APPENDIX N

NAMEHUNTER

```
//      File:  NH_util.cpp
//
//      Description:
//
//              Implementation of various utility functions used in the SNAPI
//
//
//      History:
//
//              5/15/97         EFB             Created
//              3/20/98         EFB             Changed names to NH from SN
//


#include      <string.h>


#include      "NH_util.hpp"
#include      "NHCompParms.hpp"



//      function to remove leading and trailing spaces from a string
//      in place.
// Strips the string at either end or both ends.
// Stripchars specify the characters that should
// be stripped.  We start by seeing if they want the
// trailing chars stripped, which is easy.  We simply
// work backwards from the end of the string, looking for
// the first non-strippable character, and terminate the
// string just past that character.  Then if they wanted
// leading chars stripped, we work forwards to the first
// non-strippable char, and then move that and each following
// char to the beginning of the string.
void    NH_strip(char *aString)
{
  char *end_point;
  char *ch;
  int  len;

  if ((len = strlen(aString)) != 0) { //  if there is a string
                // start at end
                end_point = aString + len - 1;
```

```
		// and work back till we get a non-space or get to
		// the begining of our string, chopping off what's left.
		// Also make sure we don't zoom right past the beginning of the
		// string.
		for (; strchr(NH_DEFAULT_WHITESPACE, *end_point) != NULL &&
end_point != aString; end_point--)
			;
		// if string was all whitespace
		if ((end_point == aString) && strchr(NH_DEFAULT_WHITESPACE,
*aString) != NULL)
			*aString = EOS;  // erase it all, and we're done, could return here
		else
			*(end_point + 1) = EOS;   // just chop off excess blanks

		// make sure there is still a string, since it might
		// have been stripped entirely above.
		if (*aString) {
			// now find first non space.  we know string has at least one
			// nonwhite space, so we don't have to check for NULL.
			for (ch = aString; strchr(NH_DEFAULT_WHITESPACE, *ch) !=
NULL; ch++)
				;
			if (ch != aString) { // if there were leading spaces, move the block
back
				char  *target = aString;
				while (*ch != EOS) {
					*target = *ch;
					target++;
					ch++;
				}
				// and get the null char also
				*target = *ch;
			} // end if (are there leading spaces?)
		} // end if (and text left?)
	} // end (is there a string at all ?)
}


char	*	NH_strrchr(char *stringStart, char *searchPos, char searchChar)
{
	while (1)	{
		if (*searchPos == searchChar)
			break;
		if (searchPos == stringStart)  {
```

```
                searchPos = NULL;          //      string not found, so return
NULL
                break;
            }
            searchPos--;
        }
        return searchPos;
}
```

```
//
//      File:  NH_queens_arrays.hpp
//
//      Description:
//
//              Contains global definitions and declarations for the valid
//              combinations of indexes for the best score calculation
//
//
//      History:
//
//              6/4/97  EFB             Created
//              3/20/98         EFB             Changed names to NH from SN
//

typedef         unsigned char byte;

        byte    twoByTwo[] = {1, 0,
                                                                0, 1};

        byte    twoByThree[] = {        1, 2,

        1, 0,

        2, 1,

        2, 0,

        0, 1,

        0, 2};

        byte    twoByFour[] = {         1, 2,

        1, 3,

        1, 0,

        2, 1,

        2, 3,

        2, 0,
```

```
3, 1,
3, 2,
3, 0,
0, 1,
0, 2,
0, 3};
byte    twoByFive[] = {         1, 2,
1, 3,
1, 4,
1, 0,
2, 1,
2, 3,
2, 4,
2, 0,
3, 1,
3, 2,
3, 4,
3, 0,
4, 1,
4, 2,
4, 3,
4, 0,
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0, 1,

0, 2,

0, 3,

0, 4};

byte    threeByThree[] = {    1, 2, 0,

1, 0, 2,

2, 1, 0,

2, 0, 1,

0, 1, 2,

0, 2, 1};

byte    threeByFour[] = {     1, 2, 3,

1, 2, 0,

1, 3, 2,

1, 3, 0,

1, 0, 2,

1, 0, 3,

2, 1, 3,

2, 1, 0,

2, 3, 1,

2, 3, 0,

2, 0, 1,

2, 0, 3,
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3, 1, 2,

3, 1, 0,

3, 2, 1,

3, 2, 0,

3, 0, 1,

3, 0, 2,

0, 1, 2,

0, 1, 3,

0, 2, 1,

0, 2, 3,

0, 3, 1,

0, 3, 2};

byte    threeByFive[] = {       1, 2, 3,

1, 2, 4,

1, 2, 0,

1, 3, 2,

1, 3, 4,

1, 3, 0,

1, 4, 2,

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1, 0, 3,

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2, 1, 3,

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0, 3, 1,

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0, 4, 1,

0, 4, 2,

0, 4, 3};

byte    fourByFour[] =      {       1, 2, 3, 0,

1, 2, 0, 3,

1, 3, 0, 2,

1, 3, 2, 0,

1, 0, 2, 3,

1, 0, 3, 2,

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0, 3, 2, 1};

byte    fourByFive[] =          {       1, 2, 3, 4,

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0, 1, 4, 3};

byte    fiveByFive[] ={         1, 2, 3, 4, 0,

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0, 1, 2, 4,
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0, 1, 3, 4,
0, 1, 4, 2,
0, 1, 4, 3};

byte  fiveByFive[] =    {     1, 2, 3, 4, 0,
1, 2, 3, 0, 4,
1, 2, 4, 3, 0,
1, 2, 4, 0, 3,
1, 2, 0, 3, 4,
1, 2, 0, 4, 2,
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0, 4, 1, 3, 2,
0, 1, 2, 3, 4,
0, 1, 2, 4, 3,
0, 1, 3, 2, 4,
0, 1, 3, 4, 2,
0, 1, 4, 2, 3,
0, 1, 4, 3, 2};
```

```
//    File:  NH_getErrorText.cpp
//
//    Description:
//
//          Implementation to the NH_getErrorText function.  This
function can
//          be used to return the error text for an associated error
code.
//
//
//    History:
//
//          6/23/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#include    "NH_get_error_text.h"


#include    <string.h>


void  NH_get_error_text(NHReturnCode errorCode, char *textBuffer, int
maxChars)
{
      char  *errorMsgPtr;

      switch      (errorCode) {
            case  NH_SUCCESS:
                  errorMsgPtr = "Operation successful";
                  break;
            case  NH_MATCH:
                  errorMsgPtr = "The comparison matched";
                  break;
            case  NH_NO_MATCH:
                  errorMsgPtr = "The comparison did not match";
                  break;
            case  NH_INVALID_SCORE_THRESH:
                  errorMsgPtr = "The threshold must be between 0.0 and
1.0";
                  break;
            case  NH_INVALID_GN_INIT_SCORE:
                  errorMsgPtr = "The GN initial score must be between
0.0 and 1.0";
                  break;
            case  NH_INVALID_NH_INIT_SCORE:
                  errorMsgPtr = "The SN initial score must be between
0.0 and 1.0";
                  break;
            case  NH_INVALID_GN_INIT_ON_INIT_MATCH_SCORE:
                  errorMsgPtr = "The GN initial on intial match score
must be between 0.0 and 1.0";
                  break;
            case  NH_INVALID_NH_INIT_ON_INIT_MATCH_SCORE:
                  errorMsgPtr = "The SN initial on intial match score
must be between 0.0 and 1.0";
                  break;
            case  NH_INVALID_NFN_SCORE:
                  errorMsgPtr = "The NFN score must be between 0.0 and
1.0";
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                break;
            case  NH_INVALID_FNU_SCORE:
                errorMsgPtr = "The FNU score must be between 0.0 and
1.0";
                break;
            case  NH_INVALID_NLN_SCORE:
                errorMsgPtr = "The NLN score must be between 0.0 and
1.0";
                break;
            case  NH_INVALID_LNU_SCORE:
                errorMsgPtr = "The LNU score must be between 0.0 and
1.0";
                break;
            case  NH_INVALID_GN_ANCHOR_FACTOR:
                errorMsgPtr = "The GN anchor score must be between 0.0
and 1.0";
                break;
            case  NH_INVALID_NH_ANCHOR_FACTOR:
                errorMsgPtr = "The SN anchor score must be between 0.0
and 1.0";
                break;
            case  NH_INVALID_GN_OOPS_FACTOR:
                errorMsgPtr = "The GN OOPS factor must be between 0.0
and 1.0";
                break;
            case  NH_INVALID_NH_OOPS_FACTOR:
                errorMsgPtr = "The SN OOPS factor must be between 0.0
and 1.0";
                break;
            case  NH_INVALID_ABS_DEL_GN_TAQ_FACTOR:
                errorMsgPtr = "The Abs delete GN TAQ factor must be
between 0.0 and 1.0";
                break;
            case  NH_INVALID_ABS_DIS_GN_TAQ_FACTOR:
                errorMsgPtr = "The Abs disregard GN TAQ factor must be
between 0.0 and 1.0";
                break;
            case  NH_INVALID_ABS_DEL_NH_TAQ_FACTOR:
                errorMsgPtr = "The Abs delete SN TAQ factor must be
between 0.0 and 1.0";
                break;
            case  NH_INVALID_ABS_DIS_NH_TAQ_FACTOR:
                errorMsgPtr = "The Abs disregard SN TAQ factor must be
between 0.0 and 1.0";
                break;
            case  NH_INVALID_DEL_GN_TAQ_FACTOR:
                errorMsgPtr = "The delete GN TAQ factor must be
between 0.0 and 1.0";
                break;
            case  NH_INVALID_DIS_GN_TAQ_FACTOR:
                errorMsgPtr = "The disregard GN TAQ factor must be
between 0.0 and 1.0";
                break;
            case  NH_INVALID_DEL_NH_TAQ_FACTOR:
                errorMsgPtr = "The delete SN TAQ factor must be
between 0.0 and 1.0";
                break;
            case  NH_INVALID_DIS_NH_TAQ_FACTOR:
                errorMsgPtr = "The disregard SN TAQ factor must be
between 0.0 and 1.0";
                break;
```

```
            case  NH_INVALID_GN_COMPRESSED_NAME_SCORE:
                  errorMsgPtr = "The GN compressed name score must be
between 0.0 and 1.0";
                  break;
            case  NH_INVALID_NH_COMPRESSED_NAME_SCORE:
                  errorMsgPtr = "The SN compressed name score must be
between 0.0 and 1.0";
                  break;
            case  NH_RESULTS_LIST_INSERT_ALLOC_FAILURE:
                  errorMsgPtr = "Could not allocate space for a new
results list";
                  break;
            case  NH_GN_VAR_TABLE_CREATION_ERROR:
                  errorMsgPtr = "Problem creating GN variant table";
                  break;
            case  NH_NH_VAR_TABLE_CREATION_ERROR:
                  errorMsgPtr = "Problem creating SN variant table";
                  break;
            case  NH_TAQ_TABLE_CREATION_ERROR:
                  errorMsgPtr = "Problem creating TAQ table";
                  break;
            case  NH_SEG_BREAK_CHARS_CREATION_ERROR:
                  errorMsgPtr = "Problem creating segment break
characters string";
                  break;
            case  NH_NOISE_CHARS_CREATION_ERROR:
                  errorMsgPtr = "Problem creating noise characters
string";
                  break;
            case  NH_INVALID_RESULTS_LIST_SIZE:
                  errorMsgPtr = "Invalid size requested for results
list";
                  break;
            case  NH_RESULTS_LIST_ALLOCATION_ERROR:
                  errorMsgPtr = "Problem creating internal results list
storage";
                  break;
            case  NH_RESULTS_ARRAY_NULL_ERROR:
                  errorMsgPtr = "Internal results list storage is
invalid";
                  break;
            case  NH_TAQ_RECORD_ALLOC_ERROR:
                  errorMsgPtr = "Problem allocating space for new TAQ
record";
                  break;
            case  NH_VARIANT_ALLOC_ERROR:
                  errorMsgPtr = "Problem allocating space for new
variant record";
                  break;
            case  NH_VARIANTS_DONT_EXIST:
                  errorMsgPtr = "The supplied names are not currently
variants";
                  break;
            case  NH_INVALID_VARIANT_SCORE:
                  errorMsgPtr = "Variant scores must be between 0.0 and
1.0";
                  break;
            case  NH_MAX_VARIANT_SIZE_INCREMENT_FAILED:
                  errorMsgPtr = "Could not increase variant storage to
add new variant relationship";
                  break;
```

```
            case  NH_VARIANT_ALREADY_RELATED:
                  errorMsgPtr = "The names are already related to each
other";
                  break;
            case  NH_COMP_PARMS_BAD_STREAM_ON_CONSTRUCT:
                  errorMsgPtr = "The comp parameters stream passed to
the constructor is invalid";
                  break;
            case  NH_COMP_PARMS_BAD_STREAM_ON_ARCHIVE:
                  errorMsgPtr = "The comp parameters stream passed to
the archiveData method is invalid";
                  break;
            case  NH_NAME_PARMS_FILE_NOISE_CHARS_ERROR:
                  errorMsgPtr = "The noise characters could not be
read";
                  break;
            case  NH_NAME_PARMS_FILE_BREAKS_CHARS_ERROR:
                  errorMsgPtr = "The break characters could not be
read";
                  break;
            case  NH_NAME_PARMS_BAD_STREAM_ON_CONSTRUCT:
                  errorMsgPtr = "The Name Parameters stream passed to
the constructor was bad";
                  break;
            case  NH_NAME_PARMS_BAD_STREAM_ON_WRITE:
                  errorMsgPtr = "The Name Parameters stream passed to
the archive method was bad";
                  break;
            case  NH_NAME_PARMS_FILE_BAD_CULTURE_CODE:
                  errorMsgPtr = "The culture code read from the Name
parameters stream was invalid";
                  break;
            case  NH_TAQ_NOT_FOUND:
                  errorMsgPtr = "The specified TAQ could not be found";
                  break;
            case  NH_TAQ_ALREADY_EXISTS:
                  errorMsgPtr = "The specified TAQ is already defined";
                  break;
            case  NH_INVALID_GN_THRESH:
                  errorMsgPtr = "The GN Threshold must be between 0.0
and 1.0";
                  break;
            case  NH_INVALID_NH_THRESH:
                  errorMsgPtr = "The SN Threshold must be between 0.0
and 1.0";
                  break;
            case  NH_INVALID_GN_WEIGHT:
                  errorMsgPtr = "The GN Weight must be between 0.0 and
1.0";
                  break;
            case  NH_INVALID_NH_WEIGHT:
                  errorMsgPtr = "The SN Weight must be between 0.0 and
1.0";
                  break;
            case  NH_INVALID_CULTURE_CODE:
                  errorMsgPtr = "The specified culture code is invalid";
                  break;
            case  NH_ERROR_READING_CUSTOM_PARAMETER_FROM_FILE:
                  errorMsgPtr = "A problem was encounter when reading a
custom parameter from a file";
                  break;
```

```
            case  NH_ERROR_WRITING_CUSTOM_PARAMETER_TO_FILE:
                  errorMsgPtr = "A problem was encounter when writing a
custom parameter to a file";
                  break;
            default:
                  errorMsgPtr = "Unknown Error";
                  break;
      }
      strncpy(textBuffer, errorMsgPtr, maxChars);
      textBuffer[maxChars] = EOS;
}
```

```
//    File:  NH_culture_codes.cpp
//
//    Description:
//
//          Definition of global array of culture code strings
//
//
//    History:
//
//          9/12/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#include    <string.h>

#include    "NH_culture_codes.h"


//    The following two global arrays must be the same size.
//    That is, they must have the same number of elements.
//    If you add or remove items, you must also update the
//    constant NH_NUM_CULTURE_CODES
//    In addition, they must maintain the same relative order
//    (for example, Arabic must be in the same position in both
//    arrays).
//    lastly, this stuff must match the NHParmsType enum type,
//    both in number and relative position. The NH_NUM_PARMS_TYPES
//    must also be kept in sync as well.
char  *NH_culture_codes[] = { NH_CULTURE_CODE_ANGLO,

                  NH_CULTURE_CODE_ARABIC,

                  NH_CULTURE_CODE_CHINESE,

                  NH_CULTURE_CODE_GENERIC,

                  NH_CULTURE_CODE_HISPANIC,

                  NH_CULTURE_CODE_KOREAN,

                  NH_CULTURE_CODE_RUSSIAN};

char  *NH_culture_strings[] = {     NH_CULTURE_STRING_ANGLO,

                  NH_CULTURE_STRING_ARABIC,

                  NH_CULTURE_STRING_CHINESE,

                  NH_CULTURE_STRING_GENERIC,

                  NH_CULTURE_STRING_HISPANIC,

                  NH_CULTURE_STRING_KOREAN,

                  NH_CULTURE_STRING_RUSSIAN};


bool  NH_validate_culture_code(NHCultureCode    cultureCode)
{
      bool  found = false;
```

```
        for (int i = 0; i < NH_NUM_CULTURE_CODES; i++)  {
                if (!strncmp(cultureCode, NH_culture_codes[i],
NH_MAX_CULTURE_CODE_LEN))     {
                        found = true;
                        break;
                }
        }
        return found;
}
```

```
//    File:  namehunter.h
//
//    Description:
//
//          shutdown and startup functions for the NameHunter system.
//          These are really just blind interfaces to the
//          NH_variant_taq_globals functions.  We do this because
//          we want to hide the details of the variants and TAQs
//          from the API user.
//
//
//    History:
//
//          9/9/97      EFB         Created
//          3/20/98     EFB         Changed names to NH from SN

#include    "namehunter.h"
#include    "NHVariantTable.hpp"
#include    "NHTAQTable.hpp"
#include    "NH_variant_taq_globals.h"
#include    "NHDigraphBitmapArray.hpp"


extern      NHVariantTable    *NH_snVariantTable;
extern      NHVariantTable    *NH_gnVariantTable;
extern      NHTAQTable              *NH_taqTable;


NHDigraphBitmapArray    globalDigraphBitmapArray;


void  NH_startup()
{
      NH_getVariantTable(NH_SURNAME_VARIANTS);
      NH_getVariantTable(NH_GIVENNAME_VARIANTS);
      NH_getTAQTable();
}


void  NH_shutdown()
{
      if (NH_snVariantTable != NULL)      {
            delete NH_snVariantTable;
            NH_snVariantTable = NULL;
      }
      if (NH_gnVariantTable != NULL)      {
            delete NH_gnVariantTable;
            NH_gnVariantTable = NULL;
      }
      if (NH_taqTable != NULL)      {
            delete NH_taqTable;
            NH_taqTable = NULL;
      }
}
```

```
//      File:  NH_getErrorText.cpp
//
//      Description:
//
//              Implementation to the NH_getErrorText function.  This function can
//              be used to return the error text for an associated error code.
//
//
//      History:
//
//              6/23/97         EFB             Created
//              3/20/98         EFB             Changed names to NH from SN
//


#include      "NH_get_error_text.h"


#include      <string.h>


void    NH_get_error_text(NHReturnCode errorCode, char *textBuffer, int maxChars)
{
        char    *errorMsgPtr;

        switch (errorCode)    {
                case    NH_SUCCESS:
                        errorMsgPtr = "Operation successful";
                        break;
                case    NH_MATCH:
                        errorMsgPtr = "The comparison matched";
                        break;
                case    NH_NO_MATCH:
                        errorMsgPtr = "The comparison did not match";
                        break;
                case    NH_INVALID_SCORE_THRESH:
                        errorMsgPtr = "The threshold must be between 0.0 and 1.0";
                        break;
                case    NH_INVALID_GN_INIT_SCORE:
                        errorMsgPtr = "The GN initial score must be between 0.0 and 1.0";
                        break;
                case    NH_INVALID_NH_INIT_SCORE:
                        errorMsgPtr = "The SN initial score must be between 0.0 and 1.0";
                        break;
                case    NH_INVALID_GN_INIT_ON_INIT_MATCH_SCORE:
```

```
                    errorMsgPtr = "The GN initial on intial match score must be
between 0.0 and 1.0";
                    break;
               case NH_INVALID_NH_INIT_ON_INIT_MATCH_SCORE:
                    errorMsgPtr = "The SN initial on intial match score must be
between 0.0 and 1.0";
                    break;
               case NH_INVALID_NFN_SCORE:
                    errorMsgPtr = "The NFN score must be between 0.0 and 1.0";
                    break;
               case NH_INVALID_FNU_SCORE:
                    errorMsgPtr = "The FNU score must be between 0.0 and 1.0";
                    break;
               case NH_INVALID_NLN_SCORE:
                    errorMsgPtr = "The NLN score must be between 0.0 and 1.0";
                    break;
               case NH_INVALID_LNU_SCORE:
                    errorMsgPtr = "The LNU score must be between 0.0 and 1.0";
                    break;
               case NH_INVALID_GN_ANCHOR_FACTOR:
                    errorMsgPtr = "The GN anchor score must be between 0.0 and
1.0";
                    break;
               case NH_INVALID_NH_ANCHOR_FACTOR:
                    errorMsgPtr = "The SN anchor score must be between 0.0 and
1.0";
                    break;
               case NH_INVALID_GN_OOPS_FACTOR:
                    errorMsgPtr = "The GN OOPS factor must be between 0.0 and
1.0";
                    break;
               case NH_INVALID_NH_OOPS_FACTOR:
                    errorMsgPtr = "The SN OOPS factor must be between 0.0 and
1.0";
                    break;
               case NH_INVALID_ABS_DEL_GN_TAQ_FACTOR:
                    errorMsgPtr = "The Abs delete GN TAQ factor must be between
0.0 and 1.0";
                    break;
               case NH_INVALID_ABS_DIS_GN_TAQ_FACTOR:
                    errorMsgPtr = "The Abs disregard GN TAQ factor must be
between 0.0 and 1.0";
                    break;
               case NH_INVALID_ABS_DEL_NH_TAQ_FACTOR:
```

```
                errorMsgPtr = "The Abs delete SN TAQ factor must be between
0.0 and 1.0";
                break;
            case NH_INVALID_ABS_DIS_NH_TAQ_FACTOR:
                errorMsgPtr = "The Abs disregard SN TAQ factor must be
between 0.0 and 1.0";
                break;
            case NH_INVALID_DEL_GN_TAQ_FACTOR:
                errorMsgPtr = "The delete GN TAQ factor must be between 0.0
and 1.0";
                break;
            case NH_INVALID_DIS_GN_TAQ_FACTOR:
                errorMsgPtr = "The disregard GN TAQ factor must be between 0.0
and 1.0";
                break;
            case NH_INVALID_DEL_NH_TAQ_FACTOR:
                errorMsgPtr = "The delete SN TAQ factor must be between 0.0
and 1.0";
                break;
            case NH_INVALID_DIS_NH_TAQ_FACTOR:
                errorMsgPtr = "The disregard SN TAQ factor must be between 0.0
and 1.0";
                break;
            case NH_INVALID_GN_COMPRESSED_NAME_SCORE:
                errorMsgPtr = "The GN compressed name score must be between
0.0 and 1.0";
                break;
            case NH_INVALID_NH_COMPRESSED_NAME_SCORE:
                errorMsgPtr = "The SN compressed name score must be between
0.0 and 1.0";
                break;
            case NH_RESULTS_LIST_INSERT_ALLOC_FAILURE:
                errorMsgPtr = "Could not allocate space for a new results list";
                break;
            case NH_GN_VAR_TABLE_CREATION_ERROR:
                errorMsgPtr = "Problem creating GN variant table";
                break;
            case NH_NH_VAR_TABLE_CREATION_ERROR:
                errorMsgPtr = "Problem creating SN variant table";
                break;
            case NH_TAQ_TABLE_CREATION_ERROR:
                errorMsgPtr = "Problem creating TAQ table";
                break;
            case NH_SEG_BREAK_CHARS_CREATION_ERROR:
                errorMsgPtr = "Problem creating segment break characters string";
```

```
                break;
            case    NH_NOISE_CHARS_CREATION_ERROR:
                errorMsgPtr = "Problem creating noise characters string";
                break;
            case    NH_INVALID_RESULTS_LIST_SIZE:
                errorMsgPtr = "Invalid size requested for results list";
                break;
            case    NH_RESULTS_LIST_ALLOCATION_ERROR:
                errorMsgPtr = "Problem creating internal results list storage";
                break;
            case    NH_RESULTS_ARRAY_NULL_ERROR:
                errorMsgPtr = "Internal results list storage is invalid";
                break;
            case    NH_TAQ_RECORD_ALLOC_ERROR:
                errorMsgPtr = "Problem allocating space for new TAQ record";
                break;
            case    NH_VARIANT_ALLOC_ERROR:
                errorMsgPtr = "Problem allocating space for new variant record";
                break;
            case    NH_VARIANTS_DONT_EXIST:
                errorMsgPtr = "The supplied names are not currently variants";
                break;
            case    NH_INVALID_VARIANT_SCORE:
                errorMsgPtr = "Variant scores must be between 0.0 and 1.0";
                break;
            case    NH_MAX_VARIANT_SIZE_INCREMENT_FAILED:
                errorMsgPtr = "Could not increase variant storage to add new
variant relationship";
                break;
            case    NH_VARIANT_ALREADY_RELATED:
                errorMsgPtr = "The names are already related to each other";
                break;
            case    NH_COMP_PARMS_BAD_STREAM_ON_CONSTRUCT:
                errorMsgPtr = "The comp parameters stream passed to the
constructor is invalid";
                break;
            case    NH_COMP_PARMS_BAD_STREAM_ON_ARCHIVE:
                errorMsgPtr = "The comp parameters stream passed to the
archiveData method is invalid";
                break;
            case    NH_NAME_PARMS_FILE_NOISE_CHARS_ERROR:
                errorMsgPtr = "The noise characters could not be read";
                break;
            case    NH_NAME_PARMS_FILE_BREAKS_CHARS_ERROR:
                errorMsgPtr = "The break characters could not be read";
```

```
                    break;
                case    NH_NAME_PARMS_BAD_STREAM_ON_CONSTRUCT:
                    errorMsgPtr = "The Name Parameters stream passed to the
constructor was bad";
                    break;
                case    NH_NAME_PARMS_BAD_STREAM_ON_WRITE:
                    errorMsgPtr = "The Name Parameters stream passed to the archive
method was bad";
                    break;
                case    NH_NAME_PARMS_FILE_BAD_CULTURE_CODE:
                    errorMsgPtr = "The culture code read from the Name parameters
stream was invalid";
                    break;
                case    NH_TAQ_NOT_FOUND:
                    errorMsgPtr = "The specified TAQ could not be found";
                    break;
                case    NH_TAQ_ALREADY_EXISTS:
                    errorMsgPtr = "The specified TAQ is already defined";
                    break;
                case    NH_INVALID_GN_THRESH:
                    errorMsgPtr = "The GN Threshold must be between 0.0 and 1.0";
                    break;
                case    NH_INVALID_NH_THRESH:
                    errorMsgPtr = "The SN Threshold must be between 0.0 and 1.0";
                    break;
                case    NH_INVALID_GN_WEIGHT:
                    errorMsgPtr = "The GN Weight must be between 0.0 and 1.0";
                    break;
                case    NH_INVALID_NH_WEIGHT:
                    errorMsgPtr = "The SN Weight must be between 0.0 and 1.0";
                    break;
                case    NH_INVALID_CULTURE_CODE:
                    errorMsgPtr = "The specified culture code is invalid";
                    break;
                case
        NH_ERROR_READING_CUSTOM_PARAMETER_FROM_FILE:
                    errorMsgPtr = "A problem was encounter when reading a custom
parameter from a file";
                    break;
                case    NH_ERROR_WRITING_CUSTOM_PARAMETER_TO_FILE:
                    errorMsgPtr = "A problem was encounter when writing a custom
parameter to a file";
                    break;
                default:
                    errorMsgPtr = "Unknown Error";
```

```
                    break;
            }
            strncpy(textBuffer, errorMsgPtr, maxChars);
            textBuffer[maxChars] = EOS;
}
```

```
//      File:  namehunter.h
//
//      Description:
//
//              shutdown and startup functions for the NameHunter system.
//              These are really just blind interfaces to the
//              NH_variant_taq_globals functions.  We do this because
//              we want to hide the details of the variants and TAQs
//              from the API user.
//
//
//      History:
//
//              9/9/97  EFB             Created
//              3/20/98         EFB             Changed names to NH from SN

#include      "namehunter.h"
#include      "NHVariantTable.hpp"
#include      "NHTAQTable.hpp"
#include      "NH_variant_taq_globals.h"
#include      "NHDigraphBitmapArray.hpp"


extern NHVariantTable      *NH_snVariantTable;
extern NHVariantTable      *NH_gnVariantTable;
extern NHTAQTable                  *NH_taqTable;


NHDigraphBitmapArray      globalDigraphBitmapArray;


void    NH_startup()
{
        NH_getVariantTable(NH_SURNAME_VARIANTS);
        NH_getVariantTable(NH_GIVENNAME_VARIANTS);
        NH_getTAQTable();
}


void    NH_shutdown()
{
        if (NH_snVariantTable != NULL)    {
                delete NH_snVariantTable;
                NH_snVariantTable = NULL;
        }
```

```
        if (NH_gnVariantTable != NULL)    {
                delete NH_gnVariantTable;
                NH_gnVariantTable = NULL;
        }
        if (NH_taqTable != NULL)    {
                delete NH_taqTable;
                NH_taqTable = NULL;
        }
}
```

```
//    File:  NHVariantTable.hpp
//
//    Description:
//
//          Interface to the NHVariantTable class.
//
//
//    History:
//
//          5/7/97      EFB         Created
//          6/23/97     EFB         Changed processing to get rid of
variant types
//                                                      as assign an
individual score for each variant pair.
//          6/23/97     EFB         Enhanced comments.
//          9/9/97      EFB         Added support for a culture code in
the variant object,
//                                                      which required
changes to this object's interaction
//                                                      with the NHVariant
class.
//          3/20/98     EFB         Changed names to NH from SN
//


/*

      Variant information consists of two names that are related, along
      with a designation of variant type, which describes how the two
      names are related.

      The following holds true in our model:

      -     if Name A is related to name B with varType V, then B is
            related to A with varType V.

      -     When constructing the table,
            only one of the pairs (A, B) or (B, A) should be entered.
The
            internals will ensure that a request of "is B related to A"
and
            a request of "is A related to B" will work.

      -     Name variants are single segments.

      Internally, we represent the information as a hash table of
      NH_VarHashTableRecord structures.  Each of these structures
      contains a name string, plus a Variant object.
      Each Variant object (a separate class) has the following:

      NHVarId                 id;
            //    unique id for each variant
      byte                    numRelatedVariants;     //    number of
other variants we are related to
      NHVarId                 variants[MAX_VARIANTS_PER_NAME]
//    array of id's
      double                  varScores[MAX_VARIANTS_PER_NAME]    //
score for each variant


//    as related to this variant
```

```
      short int         varCultures[MAX_VARIANTS_PER_NAME]  //    score
for each variant


//    as related to this variant

      The name of the variant is actually stored in the hash table node,
rather
      than the variant object.

      There are three important functions in the VariantTable class:


            bool              addVariant(char *name1, char *name2,
NHVarType varType, char *cultCode);
            NHVariant   getVariantObjectName(char *name);
            NHVarId           getVariantIdForName(char *name);


            //    The Variant has the method:
            double      getVariantScoreForIdAndCulture(NHVarId varId,
char *cultureCode);

      The variant table is built by multiple calls to addVariant() from
the
      constructor.  There is one call to addVariant() for each pair of
names
      that are related.

      addVariant() takes 2 names that are related, along with a culture
code to
      describe the relationship.

      getVariantInfoForName returns the NHVariant object associated with
the
      name (or NULL).

      getVariantIdForName() returns the id associated with the name.

      Typically, a QueryNameData object gets a pointer to it's variant
object
      up front.  Each time is gets compared to an EvalNameData object,
it
      calls the getVariantIdForName() method to get an id, which it then
passes
      the to the getVariantScoreForId() to see if the two are related.

*/


#ifndef     NHVARIANTTABLE_HPP
#define NHVARIANTTABLE_HPP


#include    "NHVariant.hpp"
#include    "NH_get_error_text.h"


//    define a const for end of string
#ifndef     EOS
```

```
#define     EOS    '\0'
#endif


//    how long can a variant be ?
#define           NH_MAX_VARIANT_LEN           30


//    define a type to specify the type of variant table
//    types are defined by a combination of culture and
//    name field.
enum  NH_VARIANT_TABLE_TYPES
{
      NH_SURNAME_VARIANTS,
      NH_GIVENNAME_VARIANTS,
      NH_EMPTY_VARIANTS
};


//    define a record in the Variant hash table
typedef struct NH_VAR_HASH_TABLE_RECORD_T {
      char
                        segment[NH_MAX_VARIANT_LEN + 1];
      NHVariant
                  *variant;
      struct
NH_VAR_HASH_TABLE_RECORD_T    *next;                  //    pointer to
next node in hash chain
} NH_VarHashTableRecord;

//    Do not change without seeing member function hash().
#define NH_MAX_VAR_HASH_TABLE_NODES 907

//    define a type that is a pointer to a NH_VarTableRecord
typedef NH_VarHashTableRecord *NH_VarHashTableRecordPtr;

//    define a type that is a table (array) of NH_VarTableRecord
typedef NH_VarHashTableRecordPtr
NH_VariantHashTable[NH_MAX_VAR_HASH_TABLE_NODES];


class NHVariantTable
{
      public:
            NHVariantTable(NH_VARIANT_TABLE_TYPES tableType);
            virtual ~NHVariantTable();


            //    returns the NHVariant object associated with the name,
            //    or NULL is there is no object for the name.
            NHVariant   *     getVariantObjectForName(char *name);

            //    returns the NHVarId associated with the name.  If
there is
            //    no variant for the name, the function returns
NH_VAR_NOT_FOUND.
            NHVarId           getVariantIdForName(char *name);

            NHReturnCode                        getStatus() {return
status;}
```

```
            NHReturnCode                        addVariant(char *name1,
char *name2, double varScore, char *cultCode);

            int         getNumHashBuckets()     {return
NH_MAX_VAR_HASH_TABLE_NODES;}

            NH_VarHashTableRecordPtr      getHashBucketStartNodeAt(int
hashTableIndex)

                        {return variantHashTable[hashTableIndex];}

            //    function to change the score associated with two
variants with a
            //    specified culture.
            //    The function return:
            //
            //          NH_SUCCESS - if things worked out OK
            //          NH_VARIANTS_DONT_EXIST - if the either name does
not exist in the table
            //
                              or the names are not already variants of
each
            //
                              other with the specified culture.
            //          NH_INVALID_VARIANT_SCORE - if the score is
invalid
            NHReturnCode      changeVariantScore(char *name1, char
*name2, char *cultureCode, double newScore);


            //    a function to remove the relationship between two
variants within
            //    a specified culture.
            //    This function is used for the VariantManager
application.
            //    If either variant ends up without a relationship after
this
            //    operation, it is left in, but when saved, the
resulting file
            //    will contain a "*" rather than a related name.  The
function can
            //    return
            //
            //          NH_SUCCESS - if things worked out OK
            //          NH_VARIANTS_DONT_EXIST - if the names are not
already variants
            NHReturnCode      removeVariantRelation(char *name1, char
*name2, char *cultureCode);

            //    return the next available id, which is the number of
            //    distinct variants in our table.
            NHVarId           getNextAvailableVarId() {return
nextAvailableVarId;}

            bool              getDirty()  {return dirty;}
            void              setDirty(bool aBool)    {dirty = aBool;}

      protected:

            //    add a variant relationship.
            virtual     NHVariant   *     getOrCreateVariantObjectForNam
```

```
e(char *name);

            NHVarId           nextAvailableVarId;


            NH_VariantHashTable           variantHashTable;

            NHReturnCode            status;                 //    are we
valid

            bool              dirty;            //    have we changed

            //    Returns an integer in the range [0,
NH_MAX_VAR_HASH_TABLE_NODES].
            inline unsigned int NHVariantTable::hash(char *string)
            {
                  char                                *p;
                  unsigned    int         i;
                  unsigned    int         sum;

                  for (p = string, i = 2, sum = 0; *p != EOS; p++, i +=
2)
                        sum += i * *p;
                  return sum % NH_MAX_VAR_HASH_TABLE_NODES;
            } // hash

      private:


};



#endif
```

```
//    File:  NHVariantTable.cpp
//
//    Description:
//
//          Implementation to the NHVariantTable class.
//
//
//    History:
//
//          5/14/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//



#include <string.h>
#include <stdio.h>


#include    "NHVariantTable.hpp"
#include    "NH_util.hpp"
#include    "NH_culture_codes.h"


NHVariantTable::NHVariantTable(NH_VARIANT_TABLE_TYPES tableType)
{
      status = NH_SUCCESS;
      dirty = false;
            //    clear out the hash table
      for (int i = 0; i < NH_MAX_VAR_HASH_TABLE_NODES; i++)
            variantHashTable[i] = NULL;

      //    initialize our variant id variable.
      nextAvailableVarId = 0;

/*    gnv test stuff
            addVariant("ED", "EDWARD", 0.7, "E ");
            addVariant("GERRY", "GENERIC", 0.7, "G ");
            addVariant("HOP", "HOPSING", 0.7, "C ");
            addVariant("NASSIR", "NARADMAN", 0.7, "A ");
            addVariant("BORRIS", "NATASIA", 0.7, "R ");
            addVariant("JUAN", "EPSTEIN", 0.7, "H ");
            addVariant("KORY", "KOREAN", 0.7, "H ");
*/

/*    snv test stufff
            addVariant("HUANG", "WONG", 0.7, "C ");
*/

      //    the following include lines are commented out because it
takes forever
      //    to compile release versions when they are left in.
      if (tableType == NH_GIVENNAME_VARIANTS)   {
//          #include "gnvdata.h"
      }
      else if (tableType == NH_SURNAME_VARIANTS)      {
//          #include "snvdata.h"
      }
}
```

```
//    release all the memory used to store NH_VarHashTableRecord
pointers
NHVariantTable::~NHVariantTable()
{
      NH_VarHashTableRecordPtr      prevRecord;
      NH_VarHashTableRecordPtr      varRecord;
      unsigned int                                          tableIndex;

      for (tableIndex = 0; tableIndex < NH_MAX_VAR_HASH_TABLE_NODES;
tableIndex++)     {
            varRecord = variantHashTable[tableIndex];
            while (varRecord != NULL)     {
                  prevRecord = varRecord;
                  varRecord = varRecord->next;
                  //    delete the record we allocated,
                  //    as well as the SNVariant object pointed to by
the
                  //    variant member of this record
                  delete prevRecord->variant;
                  delete prevRecord;
            }
      }
}


//    returns the NHVariant object associated with the name,
//    or NULL is there is no object for the name.
NHVariant   *     NHVariantTable::getVariantObjectForName(char *name)
{
      NHVariant                                                 *varia
ntObject = NULL;
      unsigned int                                          tableIndex;
      NH_VarHashTableRecordPtr      tempRecordPtr;


      //    find the hash value for the (possible) variant
      tableIndex = hash(name);

      //    go throught the records in the chain at that offset in the
      //    hash table, and try to find the variant we are looking for.
      tempRecordPtr = variantHashTable[tableIndex];
      while (tempRecordPtr != NULL) {
            if (!strcmp(tempRecordPtr->segment, name))      {
                  variantObject = tempRecordPtr->variant;
                  break;
            }
            else        //    move on to next record in the chain
                  tempRecordPtr = tempRecordPtr->next;
      }
      return variantObject;
}


//    returns the NHVariant object associated with the name,
//    or creates a new one.
NHVariant   *     NHVariantTable::getOrCreateVariantObjectForName(char
*name)
{
      NHVariant   *variantObject = getVariantObjectForName(name);
```

```
      if (variantObject == NULL)    {
            //    no object existed before, so create one and add it
            //    to the hash table.

            unsigned
int                                       tableIndex;
            NH_VarHashTableRecordPtr      prevRecord;
            NH_VarHashTableRecordPtr      newVariantHashTableRecord =
new NH_VarHashTableRecord;


            variantObject = new NHVariant(nextAvailableVarId++);
            if (variantObject != NULL)    {
                  //     find the hash value for the name
                  tableIndex = hash(name);

                  //    fill up the values in the record
                  strncpy(newVariantHashTableRecord->segment, name,
NH_MAX_VARIANT_LEN);
                  newVariantHashTableRecord->segment[NH_MAX_VARIANT_LEN]
= EOS;
                  newVariantHashTableRecord->variant = variantObject;
                  newVariantHashTableRecord->next = NULL;

                  //    now add the new record to the chain of entries
                  //    at that index.
                  prevRecord = variantHashTable[tableIndex];
                  if (prevRecord == NULL)
                        variantHashTable[tableIndex] =
newVariantHashTableRecord;
                  else  {
                        while (prevRecord->next != NULL)    {
                              prevRecord = prevRecord->next;
                        }
                        prevRecord->next = newVariantHashTableRecord;
                  }
            }
            else
                  status = NH_VARIANT_ALLOC_ERROR;
      }
      return variantObject;

}


//    returns the NHVarId associated with the name.  If there is
//    no variant for the name, the function returns NH_VAR_NOT_FOUND.
NHVarId           NHVariantTable::getVariantIdForName(char *name)
{
      NHVariant         *variantObject = getVariantObjectForName(name);
      NHVarId                 returnId;

      if (variantObject != NULL)    {
            returnId = variantObject->getVariantId();
      }
      else
            returnId = NH_VAR_NOT_FOUND;

      return returnId;
}
```

```
//    Add a variant relationship.
//    In order to do this, we must:
//
//          -     make sure both names already have entries in the hash
table
//                and if not, create them.
//          -     get the id of each entry.
//          -     add the id of each item to the variant information of
the other.
//
//    We handle the special case where the second name is a *.  This
means
//    that the name should be part of the variant table, but not related
//    to anything.  In this case,
//    we only create (or get) a NHVariant object for the name.
NHReturnCode      NHVariantTable::addVariant(char *name1, char *name2,
double varScore,
                                                      char *cultureCode)
{
      NHReturnCode      rc = NH_SUCCESS;
      NHVariant               *varObject1;
      NHVariant               *varObject2;


      if ((varScore < 0.0) || (varScore > 1.0))
            rc = NH_INVALID_VARIANT_SCORE;
      else  {
            if (NH_validate_culture_code(cultureCode))      {

                  //    Get variant object for both names.  This will
also create
                  //    a new entry if the name(s) were not in the table
already
                  varObject1 = getOrCreateVariantObjectForName(name1);

                  //    if the second name was a *, skip the creation of
the second
                  //    NHVariant object and do not associate the names.
                  if (strcmp(name2, "*")) {
                        varObject2 =
getOrCreateVariantObjectForName(name2);

                        if ((varObject1 != NULL) && (varObject2 !=
NULL))      {
                              //    now associate each with the other,
using the supplied variant type
                              rc = varObject1->addVariant(varObject2,
cultureCode, varScore);
                              if (rc == NH_SUCCESS)
                                    rc = varObject2-
>addVariant(varObject1, cultureCode, varScore);
                              }
                  }
            }
            else  {
                  //    flag it as an error, but do not mark the entire
table as bad
                  rc = NH_INVALID_CULTURE_CODE;
            }
```

```
	}

	return rc;
}


//	function to change the score associated with two variants.
//	The function return:
//
//		NH_SUCCESS - if things worked out OK
//		NH_VARIANTS_DONT_EXIST - if the either name does not exist
in the table
//
//			or the names are not already variants of each
//
//			other
//		NH_INVALID_VARIANT_SCORE - if the score is invalid
NHReturnCode	NHVariantTable::changeVariantScore(char *name1, char
*name2, char *cultureCode, double newScore)
{
	NHReturnCode	rc = NH_SUCCESS;

	if ((newScore < 0.0) || (newScore > 1.0))
		rc = NH_INVALID_VARIANT_SCORE;
	else	{
		NHVariant	*var1 = getVariantObjectForName(name1);
		NHVariant	*var2 = getVariantObjectForName(name2);

		if ((var1 == NULL) || (var2 == NULL))
			rc = NH_VARIANTS_DONT_EXIST;
		else	{
			rc = var1->setVariantScoreForIdAndCulture(var2-
>getVariantId(), cultureCode, newScore);
			if (rc == NH_SUCCESS)
				rc = var2->setVariantScoreForIdAndCulture(var1-
>getVariantId(), cultureCode, newScore);
				//	we should never have a case where the
items are related
				//	in one direction but not the other.
		}
	}

	return rc;
}



//	a function to remove the relationship between two variants.
//	If either variant ends up without a relationship after this
//	operation, it is left in, but when saved, the resulting file
//	will contain a "*" rather than a related name.  The function can
//	return
//
//		NH_SUCCESS - if things worked out OK
//		NH_VARIANTS_DONT_EXIST - if the names are not already
variants
NHReturnCode	NHVariantTable::removeVariantRelation(char *name1,
char *name2, char *cultureCode)
{
	NHReturnCode	rc = NH_VARIANTS_DONT_EXIST;
	NHVariant		*var1 = getVariantObjectForName(name1);
```

```
	NHVariant		*var2 = getVariantObjectForName(name2);

	if ((var1 == NULL) || (var2 == NULL))
		rc = NH_VARIANTS_DONT_EXIST;
	else	{
		if (var1->removeVariant(var2->getVariantId(), cultureCode)
== NH_SUCCESS)	{
			//	we should never have a case where the items are
related
			//	in one direction but not the other.
			if (var2->removeVariant(var1->getVariantId(),
cultureCode) == NH_SUCCESS)
				rc = NH_SUCCESS;
		}
	}

	return rc;
}
```

```
//    File:  NHVariant.hpp
//
//    Description:
//
//          Interface to the NHVariant class.
//
//
//    History:
//
//          6/6/97      EFB         Created
//          6/23/97     EFB         Changed processing to get rid of
variant types
//                                                      as assign an
individual score for each variant pair.
//          9/9/97      EFB         Changed object so that each
relationship has an
//                                                      associated
culture.  Several access methods have
//                                                      been changed to
allow for a culture specifier.
//          3/20/98     EFB         Changed names to NH from SN
//


/*
      Variant represents the variant information for one name.

      Currently, the name must be a single segment.

      The object contains the following information:

      NHVarId                 id;
                                                      //    unique id
for this variant
      byte                    numRelatedVariants;
                        //    how many variants are we related to?
      NHVarId                 variantIds[MAX_VARIANTS_PER_NAME];//
what are the id's of our related variants
      double                  varScores[MAX_VARIANTS_PER_NAME];   //
Score for each variant


//    in variants array above
      short int         varCultures[MAX_VARIANTS_PER_NAME]; //    Two
byte code describing the culture


      //    for this variant relationship.  These are


      //    actually char[2] codes.

      A variant knows how to add an id, type combination to its
information.
*/

#ifndef     NHVARIANT_HPP
#define NHVARIANT_HPP

#include    <stdlib.h>
```

```
#include    "NH_get_error_text.h"
#include    "NH_culture_codes.h"


typedef     unsigned char byte;


//    #define           MAX_VARIANTS_PER_NAME          30
#define           NH_INIT_VARIANTS_PER_NAME          5



//    define a constant to represent that two variants were
//    not related.
#define     NH_VARIANTS_NOT_RELATED       -1.0

//    define a variant id as a short int.
typedef     short int   NHVarId;

#define           NH_VAR_NOT_FOUND                        -1


//    define      a structure to hold the info about a related variant.
We
//    will use arrays of this structure to list the names related to
//    a variant.
typedef struct NH_RELATED_VARIANTS_T      {
      NHVarId                 variantId;  //    what is the id of our
related variant
      double                  varScore;         //    Score for this
variant, as related to the main variant


      //    in variants array above
      char                    varCulture[NH_MAX_CULTURE_CODE_LEN];
//    Two byte code describing the culture


            //    for this variant relationship.  These are


            //    actually char[2] codes.
} NH_RelatedVariants;



class NHVariant
{
      public:
            NHVariant(NHVarId newId);
            virtual     ~NHVariant();



            //    Returns the variant score for the relationship between
the
            //    the supplied variant id and the variant, within the
specified
            //    culture.  If the variants are not related, the
function returns
```

```
            //    NH_VARIANTS_NOT_RELATED.
            double getVariantScoreForIdAndCulture(NHVarId relatedVarId,
char *cultCode);

            //    allows caller to search for across cultures within
this variant
            double      getVariantScoreForIdAndAnyCulture(NHVarId
relatedVarId, char *cultCode);
            //    see if the supplied variant is related to us, and if
so,
            //    replace the existing score with the new score.
            //    if not, return NH_VARIANTS_DONT_EXIST.
            NHReturnCode setVariantScoreForIdAndCulture(NHVarId
relatedVarId,


char *cultCode, double score);

            //    adds the id of the specified variant (along with an
associated
            //    score and culture code)  to our array of variants
related to us.
            virtual     NHReturnCode      addVariant(NHVariant *variant,
char *cultureCode,

                                          double relatedVarScore);

            //    remove a variant from our list
            //    return NH_VARIANTS_DONT_EXIST if the id is not in our
list already
            virtual NHReturnCode    removeVariant(NHVarId relatedVarId,
char *cultureCode);

            //    return the variant id for this object
            NHVarId     getVariantId()    {return id;}

            //    return the variant id for this object
            byte  getNumVariants()  {return numRelatedVariants;}

            NHVarId     getIdForRelatedVariant(int relVarIndex)
            {
                  NHVarId     varId = 0;


                  if ((relVarIndex > -1) && (relVarIndex <
numRelatedVariants))
                        varId = relatedVariants[relVarIndex].variantId;
                  return varId;
            }


            char  *     getCultureCodeForRelatedVariant(int relVarIndex)
            {
                  char  *cultureCode = NULL;


                  if ((relVarIndex > -1) && (relVarIndex <
numRelatedVariants))
                        cultureCode =
relatedVariants[relVarIndex].varCulture;
                  return cultureCode;
```

```
	},

	double	getScoreForRelatedVariant(int relVarIndex)
	{
		double	score = 0.0;

		if ((relVarIndex > -1) && (relVarIndex <
numRelatedVariants))
			score = relatedVariants[relVarIndex].varScore;
		return score;
	}

protected:

	NHVarId                                                 id;
                                                        //    unique id
for this variant
	byte                                                    numRelatedVa
riants;                 //    how many variants are we related to?
	byte                                                    maxRelatedVa
riants;                 //    how many variants are we related to?
	NH_RelatedVariants      *relatedVariants;

private:

};



#endif
```

```
//    File:  NHVariant.cpp
//
//    Description:
//
//          Implementation to the NHVariant class.
//
//
//    History:
//
//          6/6/97      EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#include <string.h>
#include <stdio.h>


#include    "NHVariant.hpp"
#include    "NH_util.hpp"


#ifndef     false
#define     false 0
#endif

#ifndef     true
#define     true  1
#endif



NHVariant::NHVariant(NHVarId newId)
{
      id = newId;
      numRelatedVariants = 0;
      maxRelatedVariants = NH_INIT_VARIANTS_PER_NAME;
      relatedVariants = new NH_RelatedVariants[maxRelatedVariants];
}


NHVariant::~NHVariant()
{
      if (relatedVariants)
            delete [] relatedVariants;
}


//    see if the supplied variant is related to us, and if so, return
its score.
double      NHVariant::getVariantScoreForIdAndCulture(NHVarId
relatedVarId, char *cultCode)
{
double      returnScore = NH_VARIANTS_NOT_RELATED;

      for (int i = 0; i < numRelatedVariants; i++)    {
            if ((relatedVariants[i].variantId == relatedVarId) &&
(memcmp(relatedVariants[i].varCulture, cultCode,
NH_MAX_CULTURE_CODE_LEN) == 0))     {
                  returnScore = relatedVariants[i].varScore;
```

```
                break;
            }
        }
        return returnScore;
}


//    See if the supplied variant is related to us under any culture.
//    Because this method is intended to be called several times (for
//    possibly multiple cultures, it also takes a culture string that
//    is used to keep track of the last culture that was returned.  The
//    first time the function is called, the culture is specified as an
//    empty string.  On return, it contains the first culture found
//    in the list for the id.  The next time the function is called,
//    we look past that culture/id combination in the array looking for
//    the next one, until we return NH_VARIANTS_NOT_RELATED.
double      NHVariant::getVariantScoreForIdAndAnyCulture(NHVarId
relatedVarId, char *cultCode)
{
        double      returnScore = NH_VARIANTS_NOT_RELATED;
        bool        alreadyFoundLastCultCode = false;

        for (int i = 0; i < numRelatedVariants; i++)    {
            if ((relatedVariants[i].variantId == relatedVarId))   {
                //    ids matched, so see if they specified a culture
code
                if (*cultCode == EOS)   {
                    //    this is first time through, so no check is
necessary.
                    //    copy the cult code into the supplied
string.
                    NH_safe_strcpy(cultCode,
relatedVariants[i].varCulture, NH_MAX_CULTURE_CODE_LEN);
                    returnScore = relatedVariants[i].varScore;
                    break;
                }
                else  {
                    //    this is not first time through, they are
passing us the cult code
                    //    that was found last time, so see if we
have already found that one
                    if (alreadyFoundLastCultCode == true)     {
                        NH_safe_strcpy(cultCode,
relatedVariants[i].varCulture, NH_MAX_CULTURE_CODE_LEN);
                        returnScore = relatedVariants[i].varScore;
                        break;
                    }
                    else  {
                        //    see if this is the cult code they
passed us
                        if (memcmp(relatedVariants[i].varCulture,
cultCode, NH_MAX_CULTURE_CODE_LEN) == 0)  {
                            alreadyFoundLastCultCode =
true;       //    we found it
                        }
                    }
                }
            }
        }
        return returnScore;
}
```

```
//    see if the supplied variant is related to us, and if so,
//    replace the existing score with the new score.
//    if not, return NH_VARIANTS_DONT_EXIST.
NHReturnCode      NHVariant::setVariantScoreForIdAndCulture(NHVarId
relatedVarId,

                        char *cultCode, double score)
{
NHReturnCode      rc = NH_VARIANTS_DONT_EXIST;

      for (int i = 0; i < numRelatedVariants; i++)    {
            if ((relatedVariants[i].variantId == relatedVarId) &&
                        (memcmp(relatedVariants[i].varCulture, cultCode,
NH_MAX_CULTURE_CODE_LEN) == 0))     {
                  relatedVariants[i].varScore = score;
                  rc = NH_SUCCESS;
                  break;
            }
      }
      return rc;
}


//    add a variant to our list
//    if the variant is already in the list, do not add it a second
//    time, and return an error
NHReturnCode      NHVariant::addVariant(NHVariant *variant, char
*cultureCode,

                                    double relatedVarScore)
{
      NHReturnCode      rc = NH_SUCCESS;
      NHVarId relatedVarId = variant->getVariantId();


      //    check to see if the relationship has already been
      //    defined for this id/culture.
      for (int i = 0; i < numRelatedVariants; i++)    {
            if ((relatedVariants[i].variantId == relatedVarId) &&
                        (memcmp(relatedVariants[i].varCulture,
cultureCode, NH_MAX_CULTURE_CODE_LEN) == 0))    {
                  rc = NH_VARIANT_ALREADY_RELATED;
                  break;
            }
      }

      if (rc == NH_SUCCESS)   {
            //    see if we are maxed out
            if (numRelatedVariants == maxRelatedVariants)   {
                  //    try to reallocate the space
                  NH_RelatedVariants      *biggerBlock;

                  biggerBlock = new
NH_RelatedVariants[maxRelatedVariants * 2];

                  if (biggerBlock)  {
                        memcpy(biggerBlock, relatedVariants,
                                          sizeof(NH_RelatedVariant
```

```
s) * maxRelatedVariants);
                        delete [] relatedVariants;
                        relatedVariants = biggerBlock;
                        maxRelatedVariants *= 2;
                  }
                  else
                        rc = NH_MAX_VARIANT_SIZE_INCREMENT_FAILED;
            }
      }

      if (rc == NH_SUCCESS)   {
            relatedVariants[numRelatedVariants].variantId =
relatedVarId;
            relatedVariants[numRelatedVariants].varScore =
relatedVarScore;
            strncpy(relatedVariants[numRelatedVariants].varCulture,
cultureCode, NH_MAX_CULTURE_CODE_LEN);
            numRelatedVariants++;
      }

      return rc;
}


//    remove a variant from our list
//    return NH_VARIANTS_DONT_EXIST if the id is not in our list already
NHReturnCode      NHVariant::removeVariant(NHVarId relatedVarId, char
*cultureCode)
{
NHReturnCode      rc = NH_VARIANTS_DONT_EXIST;

      for (int i = 0; i < numRelatedVariants; i++)    {
            if ((relatedVariants[i].variantId == relatedVarId) &&
                  (memcmp(relatedVariants[i].varCulture,
cultureCode, NH_MAX_CULTURE_CODE_LEN) == 0))    {
                  //    now move any ids past the one that match
                  //    back one space.
                  for (int j = i + 1; j < numRelatedVariants;
j++)  {
                        relatedVariants[j - 1].varScore =
relatedVariants[j].varScore;
                        relatedVariants[j - 1].variantId =
relatedVariants[j].variantId;
                        strncpy(relatedVariants[j - 1].varCulture,
                                    relatedVariants[j].varCu
lture, NH_MAX_CULTURE_CODE_LEN);
                  }
                  numRelatedVariants--;         //    we not have one
less variant
                  rc = NH_SUCCESS;
                  break;
            }
      }
      return rc;
}
```

```
//    File:  NHTAQTable.hpp
//
//    Description:
//
//          Interface to the NHTAQTable class.
//
//
//    History:
//
//          5/7/97      EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//
//
//
//    The TAQTable is organized by name and culture.  That is the unique
key
//    in the table.  We do lookups by hashing the name, but must
consider the
//    culture code as we walk the hash table bucket.

#ifndef     NHTAQTABLE_HPP
#define NHTAQTABLE_HPP


#include    "NH_culture_codes.h"
#include    "NHNameData.hpp"
#include    "NH_get_error_text.h"



//    how many characters can a TAQ value be?
#define           NH_MAX_TAQ_LEN          20


//    define the possible values for the TAQ action
#define           NH_TAQ_ACTION_DELETE                'X'
#define           NH_TAQ_ACTION_DISREGARD       'D'


//    define a record in the hash table of TAQ values
typedef struct NH_TAQ_RECORD_T      {
      char    taqString[NH_MAX_TAQ_LEN + 1];    //    string that is the
TAQ value
      char        taqType;                //    P, S, I, T or Q
      char        sepIfConjoined;         //    Y or N
      char        gnAction;                     //    what to do when
found in gn
      char        snAction;                     //    what to do when
found in sn
      char        taqCulture[NH_MAX_CULTURE_CODE_LEN +
1];                     //    which culture does this apply to?
  struct NH_TAQ_RECORD_T *next;           //    pointer to next TAQ
record in this hash branch
} NH_TAQRecord;

//    Do not change without seeing function NH_TAQhash().
#define NH_MAX_TAQ_HASH_NODES 907

//    define a type that is a pointer to a NH_TAQRecord
typedef NH_TAQRecord *NH_TAQRecordPtr;
```

```
//    define a type that is a table (array) of NH_TAQRecordPtrs
typedef NH_TAQRecordPtr NH_TAQHashTable[NH_MAX_TAQ_HASH_NODES];


enum  NH_TAQ_TABLE_TYPE {
      NH_PRODUCTION_TAQ_TABLE,
      NH_EMPTY_TAQ_TABLE
};


class NHTAQTable
{
      public:
            NHTAQTable(NH_TAQ_TABLE_TYPE type);
            ~NHTAQTable();


            //    function to return a pointer to the TAQ structure for
the
            //    supplied character string (segment), cultureCode
combination.
            //    Returns NULL if the supplied segment is not known to
the TAQ table
            //    for the specified culture code.
            NH_TAQRecordPtr               getTAQSegment(char *nameSeg,
char *cultureCode);

            //    specialized version of the above function that looks
for the
            //    name segment in either of the specified culture codes.
It makes
            //    sure that if the name is found in the
primaryCultureCode, that one
            //    gets returned even if we come upon the
secondaryCultureCode first.
            NH_TAQRecordPtr               getTAQSegment(char *nameSeg,
char *primaryCultureCode,

                                          char *secondaryCultureCode);

            NHReturnCode                        getStatus() {return
status;}

            bool                                                getDirty()
{return dirty;}
            void                                                setDirty(boo
l aBool)    {dirty = aBool;}

            int                                                       getNum
HashBuckets()     {return NH_MAX_TAQ_HASH_NODES;}

            NH_TAQRecordPtr               getHashBucketStartNodeAt(int
hashTableIndex)

                        {return taqHashTable[hashTableIndex];}

            NHReturnCode                        addTAQValue(char
*taqValue, char taqType,

                                    char sepIfConjoined, char
gnTAQAction,
```

```
                                    char snTAQAction, char *taqCulture);

            NHReturnCode                        removeTAQValue(char
*taqValue, char *cultureCode);

      protected:

      private:

            //    Returns an integer in the range [0,
NH_MAX_TAQ_HASH_NODES].
            inline unsigned int     hash(char *string)
            {
                  char                          *p;
                  unsigned int      i;
                  unsigned int      sum;

                  for (p = string, i = 2, sum = 0; *p != EOS; p++, i +=
2)
                        sum += i * *p;
                  return sum % NH_MAX_TAQ_HASH_NODES;
            } /* hash */

        NH_TAQHashTable taqHashTable;
            NHReturnCode            status;                 //    are we
valid
            bool              dirty;            //    have we changed



};



#endif
```

```
//    File:  NHTAQTable.cpp
//
//    Description:
//
//          Implementation to the NHTAQTable class.
//
//
//    History:
//
//          5/14/97     EFB         Created
//          9/9/97      EFB         Added support for culture
//          3/20/98     EFB         Changed names to NH from SN
//


#include <string.h>
#include <stdio.h>


#include    "NHTAQTable.hpp"
#include    "NH_util.hpp"


NHTAQTable::NHTAQTable(NH_TAQ_TABLE_TYPE type)
{
      status = NH_SUCCESS;

      //    clear out the hash table
      for (int i = 0; i < NH_MAX_TAQ_HASH_NODES; i++)
            taqHashTable[i] = NULL;

      //    make sure we are not supposed to be doing an empty table.
      if (type == NH_PRODUCTION_TAQ_TABLE)      {
            //    parameters are:
            //
            //                TAQ string
            //                taq Type (T, P, S, Q, I),
            //                sepIfConjoined    ('Y' or 'N')
            //                Given name action       (D - delete, R -
disregard, X - not applicable)
            //                Surname action          (D - delete, R -
disregard, X - not applicable)
            //                Culture  (2 char code)

            //    include the data that was generated via the TAQmanager
tool.
            #include    "taqdata.h"

            //    This stuff is just left over from testing
      /*
            addTAQValue("DR", 'T', 'N', NH_TAQ_ACTION_DELETE,
NH_TAQ_ACTION_DELETE, NH_CULTURE_CODE_GENERIC);
            addTAQValue("MR", 'T', 'N', NH_TAQ_ACTION_DELETE,
NH_TAQ_ACTION_DELETE, NH_CULTURE_CODE_GENERIC);
            addTAQValue("MRS", 'T', 'N', NH_TAQ_ACTION_DELETE,
NH_TAQ_ACTION_DELETE, NH_CULTURE_CODE_GENERIC);
            addTAQValue("JR", 'Q', 'N', NH_TAQ_ACTION_DISREGARD,
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_GENERIC);
            addTAQValue("SR", 'Q', 'N', NH_TAQ_ACTION_DISREGARD,
```

```
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_GENERIC);
            addTAQValue("ABDUL", 'T', 'N', NH_TAQ_ACTION_DISREGARD,
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_ARABIC);
            addTAQValue("HOMEY", 'T', 'N', NH_TAQ_ACTION_DISREGARD,
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_ANGLO);
            addTAQValue("CHINTAQ", 'T', 'N', NH_TAQ_ACTION_DISREGARD,
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_CHINESE);
            addTAQValue("HISPTAQ", 'T', 'N', NH_TAQ_ACTION_DISREGARD,
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_HISPANIC);
            addTAQValue("KORTAQ", 'T', 'N', NH_TAQ_ACTION_DISREGARD,
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_KOREAN);
            addTAQValue("RUSTAQ", 'T', 'N', NH_TAQ_ACTION_DISREGARD,
NH_TAQ_ACTION_DISREGARD, NH_CULTURE_CODE_RUSSIAN);

      */
      }

      //    mark that the table has not been changed.   Usefull for
TAQManager application
      dirty = false;
}


//    release all the memory used to store the NH_TAQRecords
NHTAQTable::~NHTAQTable()
{
      NH_TAQRecord      *prevTAQRecord;
      NH_TAQRecord      *taqRecord;
      int                                 tableIndex;

      for (tableIndex = 0; tableIndex < NH_MAX_TAQ_HASH_NODES;
tableIndex++)     {
            taqRecord = taqHashTable[tableIndex];
            while (taqRecord != NULL)     {
                  prevTAQRecord = taqRecord;
                  taqRecord = taqRecord->next;
                  delete prevTAQRecord;
            }
      }
}


//    function to take the values passed in, create a NH_TAQRecord
//    structure, and add the new structure to this object's
//    taqHashTable.
NHReturnCode NHTAQTable::addTAQValue(char *taqValue, char taqType, char
sepIfConjoined,

                  char gnTAQAction, char snTAQAction, char *taqCulture)
{
      NHReturnCode      rc = NH_SUCCESS;
      NH_TAQRecord      *newTAQRecord;
      int                                 tableIndex;
      NH_TAQRecord      *prevTAQRecord;


      //    first, make sure we know the culture code
      if (NH_validate_culture_code(taqCulture)) {
            //    find the hash value for the taq
            tableIndex = hash(taqValue);
```

```
            //    now see if the taq is already defined for this culture
code
            //    At the same time, find our insertion point, which will
be either:
            //          -     the first node in the bucket, if this
bucket is empty
            //          -     the end of the bucket
            prevTAQRecord = taqHashTable[tableIndex];
            if (prevTAQRecord != NULL)    {
                  rc = NH_TAQ_ALREADY_EXISTS;                  //    assume
it exists
                  while (strcmp(prevTAQRecord->taqString, taqValue) ||
                                          (strcmp(prevTAQRecord-
>taqCulture, taqCulture)))    {
                        if (prevTAQRecord->next == NULL)          {
                              rc = NH_SUCCESS;                  //    does
not exist, so looks good so far
                              break;            //    end of bucket
chain
                        }
                        prevTAQRecord = prevTAQRecord-
>next;            //    move though bucket chain
                  }
            }

            //    if all is still ok (e.g. no duplicate)
            if (rc == NH_SUCCESS)   {
                  //    now create the new record and set its values
                  newTAQRecord = new NH_TAQRecord;
                  if (newTAQRecord != NULL)     {
                        NH_safe_strcpy(newTAQRecord->taqString,
taqValue, NH_MAX_TAQ_LEN);
                        newTAQRecord->taqType = taqType;
                        newTAQRecord->sepIfConjoined = sepIfConjoined;
                        newTAQRecord->gnAction = gnTAQAction;
                        newTAQRecord->snAction = snTAQAction;
                        NH_safe_strcpy(newTAQRecord->taqCulture,
taqCulture, NH_MAX_CULTURE_CODE_LEN);
                        newTAQRecord->next = NULL;

                        //    now add the new record to the chain of
entries (or the start of the
                        //    bucket.  We have already hashed the
tableIndex value above, and have
                        //    found the correct insertion point
                        if (prevTAQRecord == NULL)
                              taqHashTable[tableIndex] = newTAQRecord;
                        else
                              prevTAQRecord->next = newTAQRecord;
                  }
                  else  {
                        rc = NH_TAQ_RECORD_ALLOC_ERROR;
                        status = NH_TAQ_RECORD_ALLOC_ERROR;
                  }
            }
      }
      else  {
            //    flag it as an error, but do not mark the entire table
as bad
            rc = NH_INVALID_CULTURE_CODE;
```

```
	}

	return rc;
}


NH_TAQRecordPtr NHTAQTable::getTAQSegment(char *nameSeg, char
*cultureCode)
{
	int                                             tableIndex;
	NH_TAQRecordPtr   tempTAQRecordPtr;
	NH_TAQRecordPtr   returnTAQRecordPtr = NULL;


	//    find the hash value for the (possible) taq
	tableIndex = hash(nameSeg);

	//    go throught the records in the chain at that offset in the
	//    hash table, and try to find the taq we are looking for.
	tempTAQRecordPtr = taqHashTable[tableIndex];
	while (tempTAQRecordPtr != NULL)    {
		if (!strcmp(tempTAQRecordPtr->taqString, nameSeg) &&
                        !strcmp(tempTAQRecordPtr->taqCulture,
cultureCode))     {
			returnTAQRecordPtr = tempTAQRecordPtr;
			break;
		}
		else        //    move on to next record in the chain
			tempTAQRecordPtr = tempTAQRecordPtr->next;
	}
	return returnTAQRecordPtr;
}


//    specialized version of the above function that looks for the
//    name segment in either of the specified culture codes.  It makes
//    sure that if the name is found in the primaryCultureCode, that one
//    gets returned even if we come upon the secondaryCultureCode first.
NH_TAQRecordPtr               NHTAQTable::getTAQSegment(char *nameSeg,
char *primaryCultureCode,

                              char *secondaryCultureCode)
{
	int                                             tableIndex;
	NH_TAQRecordPtr   tempTAQRecordPtr;
	NH_TAQRecordPtr   returnTAQRecordPtr = NULL;


	//    find the hash value for the (possible) taq
	tableIndex = hash(nameSeg);

	//    go throught the records in the chain at that offset in the
	//    hash table, and try to find the taq we are looking for.
	tempTAQRecordPtr = taqHashTable[tableIndex];
	while (tempTAQRecordPtr != NULL)    {
		if (!strcmp(tempTAQRecordPtr->taqString, nameSeg) &&
                        !strcmp(tempTAQRecordPtr->taqCulture,
primaryCultureCode))    {
			returnTAQRecordPtr = tempTAQRecordPtr;
			break;
		}
```

```
            else        //    move on to next record in the chain
                  tempTAQRecordPtr = tempTAQRecordPtr->next;
      }

      //    see if we need to check the secondary
      if (returnTAQRecordPtr == NULL)     {
            //    go throught the records in the chain at that offset in
the
            //    hash table, and try to find the taq we are looking
for.
            tempTAQRecordPtr = taqHashTable[tableIndex];
            while (tempTAQRecordPtr != NULL)    {
                  if (!strcmp(tempTAQRecordPtr->taqString, nameSeg) &&
                              !strcmp(tempTAQRecordPtr-
>taqCulture, secondaryCultureCode)) {
                        returnTAQRecordPtr = tempTAQRecordPtr;
                        break;
                  }
                  else        //    move on to next record in the chain
                        tempTAQRecordPtr = tempTAQRecordPtr->next;
            }
      }

      return returnTAQRecordPtr;
}

//    try to remove the TAQ value specified.  If found, return
//    NH_SUCCESS. If not found, return.
//    The record is deleted if found.
NHReturnCode            NHTAQTable::removeTAQValue(char *taqValue, char
*cultureCode)
{
      NHReturnCode            rc = NH_TAQ_NOT_FOUND;
      NH_TAQRecordPtr   tempTAQRecordPtr;
      NH_TAQRecordPtr   prevTAQRecordPtr = NULL;
      int                                    tableIndex =
hash(taqValue);


      //    go throught the records in the chain at that offset in the
      //    hash table, and try to find the taq we are looking for.
      tempTAQRecordPtr = taqHashTable[tableIndex];
      while (tempTAQRecordPtr != NULL)    {
            if (!strcmp(tempTAQRecordPtr->taqString, taqValue) &&
                        !strcmp(tempTAQRecordPtr->taqCulture,
cultureCode))
                  break;
            else  {
                  //    save this as the prev
                  prevTAQRecordPtr = tempTAQRecordPtr;
                  //    move on to next record in the chain
                  tempTAQRecordPtr = tempTAQRecordPtr->next;
            }
      }

      //    once we are here, tempTAQRecordPtr will be non NULL
      //    if we found it.
      if (tempTAQRecordPtr != NULL) {
            if (prevTAQRecordPtr == NULL) {
                  //    this record was the first in the chain, so we
must alter
```

```
                    //    the hash table entry
                    taqHashTable[tableIndex] = tempTAQRecordPtr->next;
                }
                else        //    not the first in the chain, so assign the
previous one's next
                    prevTAQRecordPtr->next = tempTAQRecordPtr-
>next;       //    to our next
                delete tempTAQRecordPtr;
                rc = NH_SUCCESS;
        }

        return rc;
}
```

```
//    File:  NHQueryNameData.cpp
//
//    Description:
//
//          Implementation to the NHQueryNameData class.
//
//
//    History:
//
//          5/14/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#include <string.h>
#include <stdio.h>


#include    "NHQueryNameData.hpp"
#include    "NHVariantTable.hpp"
#include    "NHResultsList.hpp"
#include    "NH_util.hpp"
#include    "NHDigraphBitmapArray.hpp"
#include    "NHNameParms.hpp"


extern      NHDigraphBitmapArray    globalDigraphBitmapArray;

#define     NH_INDEX_THRESH   0.5


NHQueryNameData::NHQueryNameData(NHNameParms *nParms, char *aGn, char
*aSn) :
                                                    NHNameData(nParms, aGn,
aSn)
{
      resultsList = NULL;
      keysArray = NULL;
      numBitsInGnKeys = NULL;
      numBitsInSnKeys = NULL;
      processVariantValues(nParms->gnVariantTable,

nParms->snVariantTable);
}


NHQueryNameData::NHQueryNameData(NHNameParms *nParms, char *aGn, char
*aSn, char *aMn) :
                                                    NHNameData(nParms, aGn,
aSn, aMn)
{
      resultsList = NULL;
      keysArray = NULL;
      numBitsInGnKeys = NULL;
      numBitsInSnKeys = NULL;
      processVariantValues(nParms->gnVariantTable,

nParms->snVariantTable);
}
```

```
NHQueryNameData::NHQueryNameData(NHNameParms *nParms, char *name,
NHNameFormat nameFormat)      :
                                                    NHNameData(nParms, name,
nameFormat)
{
      resultsList = NULL;
      keysArray = NULL;
      numBitsInGnKeys = NULL;
      numBitsInSnKeys = NULL;
      processVariantValues(nParms->gnVariantTable,

nParms->snVariantTable);
}



NHQueryNameData::~NHQueryNameData()
{
      if (keysArray != NULL)
            delete [] keysArray;
      if (numBitsInGnKeys != NULL)
            delete [] numBitsInGnKeys;
      if (numBitsInSnKeys != NULL)
            delete [] numBitsInSnKeys;
}


//    Function to get a pointer to a NHVariant object for each name
//    segment.  We do this here, in the query
//    name, so that lookups only have to be done once for the query
name.
//    Note also that we check first to make sure that we are supposed to
be
//    using variants (we do this per name field).
void  NHQueryNameData::processVariantValues(NHVariantTable
*gnVariantTable,

                                                                NHVariantTab
le *snVariantTable)
{
      int         i;


      if (nameParms->getUseGnVariants())  {
            for (i = 0; i < numGnSegments; i++)
                  gnSegmentVariants[i] = gnVariantTable-
>getVariantObjectForName(gnSegments[i].segString);
      }
      if (nameParms->getUseSnVariants())  {
            for (i = 0; i < numSnSegments; i++)
                  snSegmentVariants[i] = snVariantTable-
>getVariantObjectForName(snSegments[i].segString);
      }
}


//    function to allocate space for, and generate, the keys for
//    this query name.  The caller calls this explicitly with the
//    desired key widths for the GN and SN.  We use these
//    values in conjunction with the numGnSegments and numSnSegments
```

```
//    to calculate how big to make the array that will hold the keys.
void  NHQueryNameData::prepareKeys(NHKeyWidth gnKeyWidth,

                                   NHKeyWidth snKeyWidth)
{
      int                                  keyArraySize;
      unsigned char     largerNumberOfSegments;
      int                                  fullKeyLen;


      //    first allocate the keys
      if (numSnSegments > numGnSegments)
            largerNumberOfSegments = numSnSegments;
      else
            largerNumberOfSegments = numGnSegments;
      if (gnKeyWidth == NH_KEY_WIDTH_32)  {
            if (snKeyWidth == NH_KEY_WIDTH_32)
                  fullKeyLen = 64;
            else
                  fullKeyLen = 96;
      }
      else  {
            if (snKeyWidth == NH_KEY_WIDTH_32)
                  fullKeyLen = 96;
            else
                  fullKeyLen = 128;
      }
      keyArraySize = largerNumberOfSegments * fullKeyLen;
      keysArray = new unsigned int[keyArraySize];

      //    save the key lengths
      queryGnKeyWidth = gnKeyWidth;
      querySnKeyWidth = snKeyWidth;

      //    now generate the keys for the query
      numBitmapKeys = genIndexKeys(largerNumberOfSegments, gnKeyWidth,

                        snKeyWidth, keysArray);

      //    now allocate space for the arrays that hold the number of
      //    bits turned on for each key in the GN and SN.
      numBitsInGnKeys = new unsigned char[largerNumberOfSegments];
      numBitsInSnKeys = new unsigned char[largerNumberOfSegments];

      unsigned char *keysArrayBytePtr = (unsigned char *)keysArray;
      for (int i = 0; i < numBitmapKeys; i++)   {
            if (gnKeyWidth == NH_KEY_WIDTH_32)  {
                  //    the number of bits turned on is the sum of the
number of bits
                  //    in each of the 4 bytes that make up the 32 bit
value
                  numBitsInGnKeys[i] =
globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePtr++)) +

            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +

            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +

            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
```

```
r++));
            }
            else  {
                  //    the number of bits turned on is the sum of the
number of bits
                  //    in each of the 8 bytes that make up the 64 bit
value
                  numBitsInGnKeys[i] =
globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePtr++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++));
            }

            // now do the surname
            if (snKeyWidth == NH_KEY_WIDTH_32)  {
                  //    the number of bits turned on is the sum of the
number of bits
                  //    in each of the 4 bytes that make up the 32 bit
value
                  numBitsInSnKeys[i] =
globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePtr++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++));
            }
            else  {
                  //    the number of bits turned on is the sum of the
number of bits
                  //    in each of the 8 bytes that make up the 64 bit
value
                  numBitsInSnKeys[i] =
globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePtr++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
```

```
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++)) +
            globalDigraphBitmapArray.getNumBitsForByte(*(keysArrayBytePt
r++));
            }

      }
}


#define     NH_EITHER_NH_OR_GN      1
#define     NH_BOTH_NH_AND_GN       2

//    function to compare the key(s) for this query name against
//    a supplied key from an eval name.  Before this function is
//    called, the caller must have called the
//    perpareKeys() method, which sets the gnKeyLength and
//    snKeyLength variables, and generates the keys for this
//    query name.
//    The comparison is performed by looking at the givename name
//    and surname portions of the key separately.  For each of these
//    subkeys, we see how many bits match, a calculate the quotient of
//    matching bits / bits that could have matched.  This score is
//    compared to ???. If the score for either the GN or SN comparison
//    is favorable, the function returns true to indicate that the
//    evaluation name associated with the supplied key is a possible
//    match, and should be retrieved for further consideration.
//    Since this object (the query) could generate multiple keys,
//    we may have to perform several comparisons.
bool  NHQueryNameData::compareKey(unsigned int  *evalBitMapKey, unsigned
char numEvalKeys)
{
      bool                                  rc = false;
      unsigned    int         *evalKeyPtr;
      unsigned    int         *queryKeyPtr;
      unsigned    int         *masterQueryKeyPtr = keysArray;
      unsigned    int         maskedVal;
      unsigned    char  numBitsThatMatched;
      unsigned    char  *bytePtr;
      bool                                  passedGn = false;
      bool                                  passedSn = false;
      int                                         indexMode =
NH_BOTH_NH_AND_GN;

      //    for each of the query's keys, do both a SN and GN comparison
      //    out nested loop compares the first GN and SN query key to
      //    all the eval keys (inner loop), and then moves on to the
```

```
next
      //    query key (outter loop).
      for (int i = 0; (i < numBitmapKeys) && (rc == false); i++)  {
            evalKeyPtr = evalBitMapKey;               //    start the
eval ptr at the beggining
            for (int j = 0; j < (int)numEvalKeys; j++)      {

                  //    place the queryKeyPtr back to the beggining of
the
                  //    current query key.  This value gets advanced
after we have
                  //    compared the current query key to all eval keys
                  queryKeyPtr = masterQueryKeyPtr;

                  //    first, check the given name
                  if (queryGnKeyWidth == NH_KEY_WIDTH_32)    {
                        //    just compare a 32 bit key for the gn
                        maskedVal = *evalKeyPtr & *queryKeyPtr;
                        bytePtr = (unsigned     char  *)&maskedVal;
                        numBitsThatMatched =
globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
));

                        if ((double)numBitsThatMatched /
(double)numBitsInGnKeys[i] > NH_INDEX_THRESH)    {
                              if (indexMode ==
NH_EITHER_NH_OR_GN)      {
                                    rc = true;
                                    break;
                              }
                              else  {
//    looking for both, is SN already set?
                                    if
(passedSn)  {           //    yes, so we matched both
                                          rc = true;
                                          break;
                                    }
                                    else
//    no, just set the gn flag
                                          passedGn = true;
                              }
                        }
                        evalKeyPtr++;     //    advance pointers
                        queryKeyPtr++;
                  }
                  else  {
                        //    just compare a 64 bit key for the gn
                        maskedVal = *evalKeyPtr & *queryKeyPtr;
                        bytePtr = (unsigned     char  *)&maskedVal;
                        numBitsThatMatched =
globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
```

```
)) +
                    globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +
                    globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
));
                         evalKeyPtr++;      //    advance pointers to get
to second 32 bits in this 64 bit key
                         queryKeyPtr++;
                         maskedVal = *evalKeyPtr & *queryKeyPtr;
                         bytePtr = (unsigned     char  *)&maskedVal;
                         numBitsThatMatched +=
globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++)) +
                    globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +
                    globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +
                    globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
));
                         if ((double)numBitsThatMatched /
(double)numBitsInGnKeys[i] > NH_INDEX_THRESH)    {
                              if (indexMode ==
NH_EITHER_NH_OR_GN)      {
                                   rc = true;
                                   break;
                              }
                              else  {
//    looking for both, is SN already set?
                                   if
(passedSn)  {          //    yes, so we matched both
                                        rc = true;
                                        break;
                                   }
                                   else
//    no, just set the gn flag
                                        passedGn = true;
                              }
                         }
                         evalKeyPtr++;      //    advance pointers
                         queryKeyPtr++;
                    }

                    //    now, check the surname
                    if (querySnKeyWidth == NH_KEY_WIDTH_32)    {
                         //    just compare a 32 bit key for the sn
                         maskedVal = *evalKeyPtr & *queryKeyPtr;
                         bytePtr = (unsigned     char  *)&maskedVal;
                         numBitsThatMatched =
globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++)) +
                    globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +
                    globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +
```

```
                globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
));

                        if ((double)numBitsThatMatched /
(double)numBitsInSnKeys[i] > NH_INDEX_THRESH)    {
                              if (indexMode ==
NH_EITHER_NH_OR_GN)      {
                                    rc = true;
                                    break;
                              }
                              else  {
//    looking for both, is GN already set?
                                    if
(passedGn)  {           //    yes, so we matched both
                                          rc = true;
                                          break;
                                    }
                                    else
//    no, just set the sn flag
                                          passedSn = true;
                              }
                        }
                        evalKeyPtr++;     //    advance pointers
                        queryKeyPtr++;
                  }
                  else  {
                        //    just compare a 64 bit key for the sn
                        maskedVal = *evalKeyPtr & *queryKeyPtr;
                        bytePtr = (unsigned     char  *)&maskedVal;
                        numBitsThatMatched =
globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
));

                        evalKeyPtr++;     //    advance pointers to get
to second 32 bits in this 64 bit key
                        queryKeyPtr++;
                        maskedVal = *evalKeyPtr & *queryKeyPtr;
                        bytePtr = (unsigned     char  *)&maskedVal;
                        numBitsThatMatched +=
globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
)) +

                  globalDigraphBitmapArray.getNumBitsForByte(*(bytePtr++
));

                        if ((double)numBitsThatMatched /
(double)numBitsInSnKeys[i] > NH_INDEX_THRESH)    {
```

```
                                    if (indexMode ==
NH_EITHER_NH_OR_GN)     {
                                          rc = true;
                                          break;
                                    }
                                    else  {
//    looking for both, is GN already set?
                                          if
(passedGn)  {           //    yes, so we matched both
                                                rc = true;
                                                break;
                                          }
                                          else
//    no, just set the sn flag
                                                passedSn = true;
                                    }
                              }
                              evalKeyPtr++;     //    advance pointers
                              queryKeyPtr++;
                        }
                  }

                  //    place the master query pointer (for the outer query
loop) at the next
                  //    query key.  We will be advancing the pointer somewhere
between 1 and 4
                  //    positions (each position is 4 bytes).
                  if (queryGnKeyWidth == NH_KEY_WIDTH_32)
                        masterQueryKeyPtr++;
                  else
                        masterQueryKeyPtr += 2;
                  if (querySnKeyWidth == NH_KEY_WIDTH_32)
                        masterQueryKeyPtr++;
                  else
                        masterQueryKeyPtr += 2;
            }

            return rc;
}
```

```
// implementation of SNParmsType helper functions

#include    <stdlib.h>
#include    <string.h>

#include    "NHParmsType.h"


int   NH_getParmsTypeIndex(NHParmsType    aParmsType);


bool  NH_validate_parms_type(NHParmsType aParmsType)
{
      return NH_getParmsTypeIndex(aParmsType) != -1;
}


char  *     NH_get_culture_string_for_parm_type(NHParmsType aParmsType)
{
      int         index = NH_getParmsTypeIndex(aParmsType);
      char  *rc;

      if (index != -1)
            rc = NH_culture_strings[index];
      else
            rc = NULL;

      return rc;
}


bool  get_culture_code_for_parms_type(NHParmsType aParmsType,
NHCultureCode cultureCode)
{
      bool  rc;
      int         index = NH_getParmsTypeIndex(aParmsType);

      if (index != -1)  {
            strncpy(cultureCode, NH_culture_codes[index],
NH_MAX_CULTURE_CODE_LEN);
            cultureCode[NH_MAX_CULTURE_CODE_LEN] = '\0';
            rc = true;
      }
      else
            rc = false;

      return rc;
}


//    function to get the ordinal position of the
//    parms type.  We use this to then index into the
//    NH_culture_codes and NH_culture_strings arrays.
//    For this to work, we must make sure that the relative
//    order of these enums and arrays stays constant.
int   NH_getParmsTypeIndex(NHParmsType    aParmsType)
{
      int   rc = aParmsType;
```

```
        if ((rc < 0) || (rc >= NH_NUM_PARMS_TYPES))
              rc = -1;
        return rc;
}
```

```
//    File:  NHResultsList.cpp
//
//    Description:
//
//          Implementation to the NHResultsList class.
//
//
//    History:
//
//          6/10/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


//    how big should the results list array start out as if
//    they want one that is expandable
#define     NH_DEFAULT_RESULTS_ARRAY_SIZE 2


#include <string.h>
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

#include    "NHResultsList.hpp"
#include    "NHEvalNameData.hpp"
#include    "NH_util.hpp"


static int NH_result_sort_function( const void *arg1, const void *arg2
);


NHResultsList::NHResultsList(int maxHits)
{
      hitArray = NULL;
      isSorted = true;
      numHitsInArray = 0;
      status = NH_SUCCESS;

      if (maxHits > 0)  {
            hitArraySize = 2 * maxHits;
            maxHitsToReturn = maxHits;
            hitArray = (NHEvalNameData **)malloc(hitArraySize *
sizeof(NHEvalNameData *));
            if (hitArray == NULL)
                  status = NH_RESULTS_LIST_ALLOCATION_ERROR;
      }
      else  {
            if (maxHits == NH_RESULTS_LIST_SIZE_EXPANDABLE) {
                  //    they want an expandable list
                  hitArraySize = NH_DEFAULT_RESULTS_ARRAY_SIZE;
                  maxHitsToReturn = NH_RESULTS_LIST_SIZE_EXPANDABLE;
                  hitArray = (NHEvalNameData **)malloc(hitArraySize *
sizeof(NHEvalNameData *));
                  if (hitArray == NULL)
                        status = NH_RESULTS_LIST_ALLOCATION_ERROR;
            }
            else  {
                  status = NH_INVALID_RESULTS_LIST_SIZE;
                  hitArraySize = 0;
```

```
                maxHitsToReturn = 0;
            }
        }

}


NHResultsList::~NHResultsList()
{
        for (int i = 0; i < numHitsInArray; i++)  {
            delete hitArray[i];
        }
        free(hitArray);
}


NHEvalNameData    *     NHResultsList::getHitAt(int anIndex)
{
        NHEvalNameData    *returnHit;

        //    first make sure the list is sorted
        if (isSorted == false)  {
            sortHits();
        }

        //    now make sure the requested index is valid
        if ((anIndex >= 0) && (anIndex < numHitsInArray))
            returnHit = hitArray[anIndex];
        else
            returnHit = NULL;

        return returnHit;
}


//    add a hit to the results list.  We make a copy of the hit using
//    the default constructor.  This should work ok, since do not
//    do any dynamic allocation in the class or its subclass.  If this
//    ever changes, we will need to create a copy constructor for
//    the NHEvalNameData and NHNameData classes.
NHReturnCode      NHResultsList::addHit(NHEvalNameData      *aHit)
{
        NHEvalNameData    **newHitArray;
        NHReturnCode            rc = NH_SUCCESS;
        NHEvalNameData    *hitCopy = new NHEvalNameData(*aHit);


        //    *hitCopy = *aHit;
        //    if we are supposed to expand
        if (maxHitsToReturn == NH_RESULTS_LIST_SIZE_EXPANDABLE)     {
            if (numHitsInArray + 1 == hitArraySize)   {
                //    we are full, so we must reallocate
                newHitArray = (NHEvalNameData **)realloc(hitArray,
hitArraySize * 2 * sizeof(NHEvalNameData *));
                if (newHitArray != NULL)      {
                    hitArray = newHitArray;
                    hitArraySize *= 2;
                }
                else
                    rc = NH_RESULTS_LIST_INSERT_ALLOC_FAILURE;
            }
```

```
            if (rc == NH_SUCCESS)   {
                  hitArray[numHitsInArray] = hitCopy;
                  isSorted = false;
                  numHitsInArray++;
            }
      }
      else  {
            if (hitArray != NULL)   {
                  hitArray[numHitsInArray] = hitCopy;
                  numHitsInArray++;
                  isSorted = false;
                  //    first, make sure our list is not full yet
                  if (numHitsInArray >= hitArraySize)
                        sortHits();
            }
            else
                  rc = NH_RESULTS_ARRAY_NULL_ERROR;
      }
      return rc;
}


//    sort the hits, and make sure there are no more than
//    maxHitsToReturn items in the array.  Any excess items
//    should be deleted, and the numHitsInArray variable
//    set to be equal to maxHitsToReturn
void  NHResultsList::sortHits()
{
      //    first, make sure we have something to sort
      if (numHitsInArray > 1) {
            //    sort the hits
            qsort(hitArray, numHitsInArray, sizeof(NHEvalNameData *),
                                    NH_result_sort_function);
            //    now, if we have more hits than they wanted, chop some
off
            //    but only chop if we are not expandable
            if (maxHitsToReturn !=
NH_RESULTS_LIST_SIZE_EXPANDABLE)    {
                  if (numHitsInArray > maxHitsToReturn)     {
                        for (int i = maxHitsToReturn; i <
numHitsInArray; i++)
                              delete hitArray[i];
                        //    reflect the new number of hits in the
array
                        numHitsInArray = maxHitsToReturn;
                  }
            }
      }
      isSorted = true;
}


//    return the number of hits.  We need to make sure that if
//    we are using a fixed size, we do not return a value greater
//    than the number they requested.
int   NHResultsList::getNumHits(void)
{
      if (maxHitsToReturn == NH_RESULTS_LIST_SIZE_EXPANDABLE)
            return numHitsInArray;
      else
            return numHitsInArray < maxHitsToReturn ?
```

```
                                        numHitsInArray : maxHitsToReturn;
}


//    compare function for the results list.  Here, we cast the
//    arguments to pointers to NHEvalNameData objects, and compare
//    their scores to see who is larger.
int NH_result_sort_function( const void *arg1, const void *arg2 )
{
      NHEvalNameData *item1 = * (NHEvalNameData **) arg1;
      NHEvalNameData *item2 = * (NHEvalNameData **) arg2;

  return item1->compareScore(item2);
}
```

```
//    File:  NHNameParms.cpp
//
//    Description:
//
//          Implementation to the NHNameParms class.
//
//
//    History:
//
//          2/27/98     EFB         Created to separate pre-processing
parameters from
//                                                    comparison
parameters.
//          3/20/98     EFB         Changed names to NH from SN
//


#include <string.h>
#include <stdio.h>
#include <stdlib.h>


#include    "NHNameParms.hpp"
#include    "NHVariantTable.hpp"
#include    "NHTAQTable.hpp"

#include    "NH_variant_taq_globals.h"
#include    "NHParmsType.h"


NHNameParms::NHNameParms(NHParmsType aParmsType,

bool gnVariants, bool snVariants,

bool gnTaqs, bool snTaqs,

bool gnUnknowns, bool snUnknowns,

const char *segBreakCharacters,

const char *noiseCharacters)
{
      //    assume success
      status = NH_SUCCESS;

      //    set these to NULL until we get them
      gnVariantTable = NULL;
      snVariantTable = NULL;
      taqTable = NULL;
      segmentBreakChars = NULL;
      noiseChars = NULL;

      parmsType = aParmsType;

      //    set up the culture codes with the one they specified as the
      //    primary, and generic as the secondary.
      //    This also makes sure the specified culture is valid
      if ((get_culture_code_for_parms_type(aParmsType,
primaryCultureCode) == false) ||
                  (get_culture_code_for_parms_type(NH_PARMS_GENERIC,
```

```
secondaryCultureCode) == false))
            status = NH_INVALID_PARMS_TYPE;
      else  {
            //    copy the callers specifications
            useGnVariants = gnVariants;
            useSnVariants = snVariants;
            checkGnUnknowns = gnUnknowns;
            checkSnUnknowns = snUnknowns;
            separateGnTaqs = gnTaqs;
            separateSnTaqs = snTaqs;

            //    create an artificial loop to cycle through the rest of
the
            //    items that need to be created.  If more items need to
be
            //    added or removed, make sure the 5 changes below).
            for (int i = 0; (i < 5) && (status == NH_SUCCESS);
i++)  {
                  switch (i)  {
                        case 0:
                              gnVariantTable =
NH_getVariantTable(NH_GIVENNAME_VARIANTS);
                              if (gnVariantTable == NULL)
                                    status =
NH_GN_VAR_TABLE_CREATION_ERROR;
                              else
                                    status = gnVariantTable-
>getStatus();
                              break;
                        case 1:
                              snVariantTable =
NH_getVariantTable(NH_SURNAME_VARIANTS);
                              if (snVariantTable == NULL)
                                    status =
NH_NH_VAR_TABLE_CREATION_ERROR;
                              else
                                    status = snVariantTable-
>getStatus();
                              break;
                        case 2:
                              taqTable = NH_getTAQTable();
                              if (taqTable == NULL)
                                    status =
NH_TAQ_TABLE_CREATION_ERROR;
                              else
                                    status = taqTable->getStatus();
                              break;
                        case 3:
                              //    provide a default if they specified
NULL;
                              if (segBreakCharacters == NULL)
                                    segmentBreakChars =
strdup(NH_DEFAULT_SEG_DELIM_CHARS);
                              else
                                    segmentBreakChars =
strdup(segBreakCharacters);
                              if (segmentBreakChars == NULL)
                                    status =
NH_SEG_BREAK_CHARS_CREATION_ERROR;
                              break;
                        case 4:
```

```
                                    //    provide a default if they specified
NULL;
                                    if (noiseCharacters == NULL)
                                          noiseChars =
strdup(NH_DEFAULT_NOISE_CHARS);
                                    else
                                          noiseChars =
strdup(noiseCharacters);
                                    if (noiseChars == NULL)
                                          status =
NH_NOISE_CHARS_CREATION_ERROR;
                                    break;
                              }
                        }
                  }
            }

//    constructor to read from file stream
NHNameParms::NHNameParms(istream &inStream)
{
      status = NH_SUCCESS;          //    assume success
      segmentBreakChars = NULL;
      noiseChars = NULL;

      if (inStream.good())    {
            inStream.read((char *)&parmsType, sizeof(NHParmsType));
            inStream.read((char *)&useGnVariants, sizeof(bool));
            inStream.read((char *)&useSnVariants, sizeof(bool));
            inStream.read((char *)&separateGnTaqs, sizeof(bool));
            inStream.read((char *)&separateSnTaqs, sizeof(bool));
            inStream.read((char *)&checkGnUnknowns, sizeof(bool));
            inStream.read((char *)&checkSnUnknowns, sizeof(bool));

            // write the culture strings.
            inStream.read((char *)primaryCultureCode,
NH_MAX_CULTURE_CODE_LEN + 1);
            inStream.read((char *)secondaryCultureCode,
NH_MAX_CULTURE_CODE_LEN + 1);

            int   stringLen;
            char  tempString[200 + 1];
            //    read string as the length, followed by the null
terminated
            //    string, including the NULL
            inStream.read((char *)&stringLen, sizeof(int));

            //    make sure we read a reasonable amount from the file
            if (stringLen <= 200)   {
                  inStream.read((char *)tempString, stringLen + 1);
                  setSegmentBreakChars(tempString);

                  //    write out string as the length, followed by the
null terminated
                  //    string, including the NULL
                  inStream.read((char *)&stringLen, sizeof(int));
                  if (stringLen <= 200)   {
                        inStream.read((char *)tempString, stringLen +
1);
                        setNoiseChars(tempString);
                  }
```

```
                else
                        status = NH_NAME_PARMS_FILE_NOISE_CHARS_ERROR;
                }
                else
                        status = NH_NAME_PARMS_FILE_BREAKS_CHARS_ERROR;
        }
        else
                status = NH_NAME_PARMS_BAD_STREAM_ON_CONSTRUCT;

        //      as a last check, make sure the culture code is valid
        if (status == NH_SUCCESS)       {
                if (NH_validate_culture_code(primaryCultureCode) == false)
                        status = NH_NAME_PARMS_FILE_BAD_CULTURE_CODE;
                else
                        if (NH_validate_culture_code(secondaryCultureCode) ==
false)
                                status = NH_NAME_PARMS_FILE_BAD_CULTURE_CODE;
        }
}


NHNameParms::~NHNameParms()
{
        if (segmentBreakChars != NULL)
                free(segmentBreakChars);
        if (noiseChars != NULL)
                free(noiseChars);
}


//      write out the NHNameParms object to a file so that it can
//      be read in at a later time.
NHReturnCode        NHNameParms::archiveData(ostream &outStream)
{
        NHReturnCode        rc = NH_SUCCESS;

        if (outStream.good())   {
                outStream.write((char *)&parmsType, sizeof(NHParmsType));
                outStream.write((char *)&useGnVariants, sizeof(bool));
                outStream.write((char *)&useSnVariants, sizeof(bool));
                outStream.write((char *)&separateGnTaqs, sizeof(bool));
                outStream.write((char *)&separateSnTaqs, sizeof(bool));
                outStream.write((char *)&checkGnUnknowns, sizeof(bool));
                outStream.write((char *)&checkSnUnknowns, sizeof(bool));

                // write the culture strings, plus their NULL terminators.
                outStream.write((char *)primaryCultureCode,
NH_MAX_CULTURE_CODE_LEN + 1);
                outStream.write((char *)secondaryCultureCode,
NH_MAX_CULTURE_CODE_LEN + 1);

                int     stringLen;
                //      write out string as the length, followed by the null
terminated
                //      string, including the NULL
                stringLen = strlen(segmentBreakChars);
                outStream.write((char *)&stringLen, sizeof(int));
                outStream.write((char *)segmentBreakChars, stringLen + 1);

                //      write out string as the length, followed by the null
terminated
```

```
            //    string, including the NULL
            stringLen = strlen(noiseChars);
            outStream.write((char *)&stringLen, sizeof(int));
            outStream.write((char *)noiseChars, stringLen + 1);
      }
      else
            rc = NH_NAME_PARMS_BAD_STREAM_ON_WRITE;
      status = rc;
      return rc;
}


NHReturnCode      NHNameParms::setSegmentBreakChars(char *segBreakChars)
{
      NHReturnCode      retCode = NH_SUCCESS;

      //    first get rid of the old set of characters
      if (segmentBreakChars != NULL)      {
            free(segmentBreakChars);
            segmentBreakChars = NULL;
      }

      //    if they gave us a string to set, go ahead and
      //    make a copy of it
      //    If they gave us NULL, make a
      //    copy of an empty string, so we wont have to worry
      //    about accessing a NULL later on.
      if (segBreakChars == NULL)
            segBreakChars = "";
      segmentBreakChars = strdup(segBreakChars);
      if (segmentBreakChars == NULL)
            retCode = NH_SEG_BREAK_CHARS_CREATION_ERROR;

      return retCode;
}


NHReturnCode      NHNameParms::setNoiseChars(char *string)
{
      NHReturnCode      retCode = NH_SUCCESS;

      //    first get rid of the old set of characters
      if (noiseChars != NULL) {
            free(noiseChars);
            noiseChars = NULL;
      }

      //    if they gave us a string to set, go ahead and
      //    make a copy of it.  If they gave us NULL, make a
      //    copy of an empty string, so we wont have to worry
      //    about accessing a NULL later on.
      if (string == NULL)
            string = "";
      noiseChars = strdup(string);
      if (noiseChars == NULL)
            retCode = NH_NOISE_CHARS_CREATION_ERROR;

      return retCode;
}
```

```
//    File:  NHNameData.cpp
//
//    Description:
//
//          Implementation to the NHNameData class.
//
//
//    History:
//
//          5/8/97      EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#include <string.h>
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

#include    "NHNameData.hpp"
#include    "NHTAQTable.hpp"
#include    "NHVariantTable.hpp"
#include    "NH_util.hpp"
#include    "NHDigraphBitmapArray.hpp"
#include    "NHNameParms.hpp"


extern      NHDigraphBitmapArray    globalDigraphBitmapArray;


NHNameData::NHNameData(NHNameParms *nParms, char *aGn, char *aSn)
{
      nameStorage = NULL;
      int   gnLen = strlen(aGn);
      int   snLen = strlen(aSn);
      if (gnLen > NH_MAX_GN_LEN)
            gnLen = NH_MAX_GN_LEN;
      if (snLen > NH_MAX_NH_LEN)
            snLen = NH_MAX_NH_LEN;
      allocateNameStorage(gnLen, snLen);
//    NH_safe_strcpy(gn, aGn, NH_MAX_GN_LEN);
//    NH_safe_strcpy(sn, aSn, NH_MAX_NH_LEN);
      NH_safe_strcpy(gn, aGn, gnLen);
      NH_safe_strcpy(sn, aSn, snLen);

      //    save a pointer to the parameters
      nameParms = nParms;

      //    Do the pre-processing on the new name
      preprocessName(nParms->getNoiseChars(), nParms-
>getSegmentBreakChars());
      processTAQValues(nParms->taqTable);

}


NHNameData::NHNameData(NHNameParms *nParms, char *aGn, char *aSn, char
*aMn)
{
      int   gnLen = strlen(aGn);
```

```
	int	mnLen = strlen(aMn);
	int	snLen = strlen(aSn);
	int	gnAllocLen = gnLen + mnLen + 1;		//	space for
the gn, mn and the implied

							//	space inbetween

	if (gnAllocLen > NH_MAX_GN_LEN)
		gnAllocLen = NH_MAX_GN_LEN;
	if (snLen > NH_MAX_NH_LEN)
		snLen = NH_MAX_NH_LEN;

	//	allocate internal space for the gn and sn
	allocateNameStorage(gnAllocLen, snLen);

//	NH_safe_strcpy(gn, aGn, NH_MAX_GN_LEN);
//	NH_safe_strcpy(sn, aSn, NH_MAX_NH_LEN);
	NH_safe_strcpy(gn, aGn, gnAllocLen);
	NH_safe_strcpy(sn, aSn, snLen);

	//	now append the middle name onto the gn, but
	//	make sure we do not exceed the max allowed chars
	//	which is currently the number of chars allowed for
	//	GN.
	//	We also append a space to the end of the gn so the
	//	middle name is separated from it.
	if (gnLen < NH_MAX_GN_LEN)	{			//	make
sure there is atleast some room
		strcat(gn + gnLen, " ");
//		NH_safe_strcpy(gn + gnLen + 1, aMn, NH_MAX_GN_LEN - (gnLen +
1));
		NH_safe_strcpy(gn + gnLen + 1, aMn, gnAllocLen - (gnLen +
1));
	}

	//	Things past here are things that need to be done for all
constructors
	//	so we may want to move them into a single function that each
of the
	//	constructors can call.

	//	save a pointer to the parameters
	nameParms = nParms;

	//	Do the pre-processing on the new name
	preprocessName(nParms->getNoiseChars(), nParms-
>getSegmentBreakChars());
	processTAQValues(nParms->taqTable);

}


//	create a name from a single string.  The caller passes in a
//	NHNameFormat telling us the format.
//	We break the string up into GN and SN.  We currently support
//		NH_SURNAME_COMMA_GIVENNAME,
//		NH_LAST_SEG_IS_SURNAME,
//		NH_NAME_FORMAT_UNKNOWN.
//
//	For NH_SURNAME_COMMA_GIVENNAME, we place everything to the left of
//	a comma in the surname, everything to the right in the given name,
```

```
//    and remove the comma.  If there is no comma, the entire string
//    goes into the given name.
//    for NH_LAST_SEG_IS_SURNAME, the last segment becomes the surname,
//    and all other segments go into the given name.  The process is
smart
//    enough to recognize TAQ values when determining the "last"
//    segment, so that trailing TAQ values are not considered the last
//    segment.  Instead, the last non-TAQ segment is treated as the
//    last segment.  Since the surname should include prefixes and
//    suffixes to the "last" segment, we must walk backwards from
//    the "last" segment looking for prefixes (TAQ values that occur
//    before the "last" segment, and are associated with the "last"
//    segment.  Some example below help clarify:
//
//          Ed Barker SR  -->                                        GN =
Ed                    SN = Barker SR
//          Maria De Lahosa Esquire  -->  GN = Maria        SN = De
Lahosa Esquire
//          Maria NIETA De Lahosa Esquire  -->  GN = Maria
NIETA       SN = De Lahosa Esquire
//          Maria consuala De Lahosa Esquire  -->  GN = Maria
consuala          SN = De Lahosa Esquire
//
//          Example1 is simple - SR is a qualifier (suffix), so It gets
placed
//          as part of the surname, along with barker, which is the last
//          real segment.
//
//          Example2 adds the idea of a prefix (De), which gets
assiciated
//          with the last real segment "Lahosa".  There is also a
qualifer
//          "Esquire" that gets associated with Lahosa.
//
//          Example3 differs from example 2 in that there is another TAQ
//          value "NIETA", but it is a qualifier that appears before the
//          "last" real segment, so it does NOT get assicated with the
//          Surname.
//
//          Example 4 is similar to example 3, except the "consuala"
//          segment is not a TAQ value, so it gets associated with the
//          Given name (since by default we only use one segment
//          for the surname.
//
//    If a name is just one
//    segment, it becomes the surname, and the given name is blank.
//    Currently, NH_NAME_FORMAT_UNKNOWN is treated the same as
//    NH_LAST_SEG_IS_SURNAME.
NHNameData::NHNameData(NHNameParms *nParms, char *name, NHNameFormat
nameFormat)
{
      //    Need to spilt up the name here, so that the
      //    last segment goes into the sn field, and all other
      //    parts of the name go into the gn field.

      if (nameFormat == NH_SURNAME_COMMA_GIVENNAME)    {
            char  *firstComma;

            firstComma = strrchr(name, ',');
            if (firstComma != NULL) {
                  //    found a comma, so copy everything up to there
```

```
into the
                //    sn field
                int   snLen = firstComma - name;
                int   gnLen = strlen(firstComma + 1);

                //    make sure the strings are not too big
                if (gnLen > NH_MAX_GN_LEN)
                      gnLen = NH_MAX_GN_LEN;
                if (snLen > NH_MAX_NH_LEN)
                      snLen = NH_MAX_NH_LEN;

                //    allocate space for names and segments
                allocateNameStorage(gnLen, snLen);

                //    make sure the comma was not too far into the
string,
                //    i.e. make sure we do not copy to many chars into
the sn
                NH_safe_strcpy(sn, name, snLen);

                //    copy everything past the comma into the give
name
//              NH_safe_strcpy(gn, firstComma + 1, NH_MAX_GN_LEN);
                NH_safe_strcpy(gn, firstComma + 1, gnLen);
                NH_strip(gn);
            }
            else  {
                //    no comma found, so put everything in the GN
                //    and blank out the sn.
                int   gnLen = strlen(name);

                if (gnLen > NH_MAX_GN_LEN)
                      gnLen = NH_MAX_GN_LEN;
                allocateNameStorage(gnLen, 0);
                NH_safe_strcpy(gn, name, gnLen);
//              NH_safe_strcpy(gn, name, NH_MAX_NH_LEN);
                *sn = EOS;
            }
      }
      else  {
            //    allocate for a worst case
            allocateNameStorage(NH_MAX_GN_LEN, NH_MAX_NH_LEN);
            //    name format must be NH_LAST_SEG_IS_SURNAME or
NH_NAME_FORMAT_UNKNOWN
            char  *lastSpace;

            //    copy the entire string into the given name
            //    and strip it.  We must strip it because we do not
            //    want to find spaces that occur at the end of the name
-
            //    this would keep us from getting the last segment
properly.
            NH_safe_strcpy(gn, name, NH_MAX_GN_LEN);
            NH_strip(gn);

            lastSpace = strrchr(gn, ' ');
            if (lastSpace != NULL)  {
                  char  tempSegment[NH_MAX_NH_LEN + 1];
                  char  *segmentEndPtr = gn + strlen(gn) -
1;          //    points to end of last segment
                  char  *lastRealSegmentStart = gn;         //    assume
```

```
we have all TAQ values,
                                                        //    in which
case we place them
                                                        //    all into the
SN field.
                NH_TAQRecordPtr   tempTAQRecordPtr; //    pointer to
structure for a TAQ record
                char                                *primaryCultureCod
e = nParms->primaryCultureCode;
                char                                *secondaryCultureC
ode = nParms->secondaryCultureCode;
                NHTAQTable              *taqTable = nParms->taqTable;

                while (lastSpace != NULL)     {
                      //    found a space, so see if this segment is a
TAQ value
                      NH_safe_strcpy(tempSegment, lastSpace + 1,
segmentEndPtr - lastSpace);
                      strupr(tempSegment);

                      //    see if this segment is a TAQ value
                      tempTAQRecordPtr = taqTable-
>getTAQSegment(tempSegment,

            primaryCultureCode,


            secondaryCultureCode);
                      //    if this value was not a TAQ value, then
this segment
                      //    is the real last segment.
                      if (tempTAQRecordPtr == NULL) {
                            lastRealSegmentStart = lastSpace + 1;
                            break;
                      }
                      //    we can safely look at lastSpace - 1
because the entire
                      //    gn was stripped, so the leading character
in the gn
                      //    could not be a space.  Thus, if we have a
space, we are
                      //    not at the begining of the string
                      segmentEndPtr = lastSpace -
1;          //    get ptr to end of prev segment
                      lastSpace = NH_strrchr(gn, segmentEndPtr, ' ');
                }

                //    when we are here, lastRealSegmentStart points to
the start
                //    of the last real segment.  However, there may be
TAQ values
                //    preceeding the last real segment that are
prefixes or titles,
                //    in which case they should be associated with the
surname.
                if (lastSpace != NULL)  {
                      segmentEndPtr = lastSpace -
1;          //    get ptr to end of prev segment
```

```
                        lastSpace = NH_strrchr(gn, segmentEndPtr, ' ');
                        if (lastSpace == NULL)
                              lastSpace = gn -
1;                  //    make sure we check the first segment
                        while (1)   {     //    breaks get us out of
this loop
                              NH_safe_strcpy(tempSegment, lastSpace + 1,
segmentEndPtr - lastSpace);
                              strupr(tempSegment);

                              tempTAQRecordPtr = taqTable-
>getTAQSegment(tempSegment,


                  primaryCultureCode,


                  secondaryCultureCode);
                              //    if this value was not a TAQ value,
then it should
                              //    not be associated with the surname,
so just break.
                              if (tempTAQRecordPtr == NULL) {
                                    break;
                              }
                              else  {
                                    //    this segment was a TAQ value.
If it is a prefix or a
                                    //    title, we should associated it
with the surname.  Otherwise
                                    //    just break, so it gets placed
with the given name
                                    if ((tempTAQRecordPtr->taqType !=
'P') && (tempTAQRecordPtr->taqType != 'T'))
                                          break;
                                    else
                                          lastRealSegmentStart =
lastSpace + 1;                //    include this TAQ as part of sn
                              }
                              if (lastSpace == (gn - 1))
                                    break;            //    already
checked first segment
                              else  {
                                    segmentEndPtr = lastSpace -
1;          //    get ptr to end of prev segment
                                    lastSpace = NH_strrchr(gn,
segmentEndPtr, ' ');
                                    if (lastSpace == NULL)
                                          lastSpace = gn -
1;                //    make sure we check the first segment
                                    }
                              }
                  }

                  NH_safe_strcpy(sn, lastRealSegmentStart,
NH_MAX_NH_LEN);
                  *lastRealSegmentStart = EOS;        //    terminate
the GN
            }
            else  {           //    no space found in name, so put
everything in surname field
```

```
                NH_safe_strcpy(sn, gn, NH_MAX_NH_LEN);
                *gn = EOS;
            }
        }

        //    save a pointer to the parameters
        nameParms = nParms;

        //    Do the pre-processing on the new name
        preprocessName(nParms->getNoiseChars(), nParms-
>getSegmentBreakChars());
        processTAQValues(nParms->taqTable);
}


//    constuct an object from an archived representation in
//    a stream.
//
//    The archive is in the following order
//
//    gnLen
//    snLen
//    nameStorage
NHNameData::NHNameData(NHNameParms *nParms, istream &inStream)
{
        short int         gnLen;
        short int         snLen;


        //    save a pointer to the parameters
        nameParms = nParms;

        //    read the given name len and surname len
        inStream.read((char *)&gnLen, sizeof(gnLen));
        if (inStream.gcount() == sizeof(gnLen))    {
            inStream.read((char *)&snLen, sizeof(snLen));

            if (inStream.gcount() == sizeof(snLen))    {
                //    allocate space based on the name lengths
                allocateNameStorage(gnLen, snLen);

                //    read the name data into the allocated storage.
                inStream.read(nameStorage, variableNameAllocSize);

                //    read in the number of gn segments
                if (inStream)
                    inStream.read((char *)&numGnSegments,
sizeof(numGnSegments));

                if (inStream)      {
                    //    read in the gn segments.  These have been
stored in a special
                    //    format, with the offset of the segString
as the first item
                    unsigned short int      segOffset;
                    for (int i = 0; i < numGnSegments; i++)    {
                        //    first, read in the offset (into the
gnSegs area) of the segString
                        if (inStream)
                            inStream.read((char *)&segOffset,
sizeof(unsigned short int));
```

```
                        if (inStream)     {
                              //    update the pointer
                              if (segOffset == (unsigned short
int)-1)
                                    gnSegments[i].segString = "";
                              else
                                    gnSegments[i].segString =
gnSegString + segOffset;
                        }

                        //    now, read in the number of TAQs
                        inStream.read((char
*)&(gnSegments[i].numTAQs), sizeof(unsigned char));

                        if (inStream)     {
                              //    now read in the TAQs.  These
are stored just like the segment,
                              //    such that the leading element
is the offset of the segString.
                              for (int j = 0; j <
gnSegments[i].numTAQs; j++)   {
                                    //    first, the offset
                                    inStream.read((char
*)&segOffset, sizeof(unsigned short int));
                                    gnSegments[i].taqList[j].segSt
ring = gnSegString + segOffset;

                                    //    next, the TAQ action
                                    inStream.read((char
*)&(gnSegments[i].taqList[j].taqAction), sizeof(char));

                                    //    lastly, the TAQ type
                                    inStream.read((char
*)&(gnSegments[i].taqList[j].taqType), sizeof(char));
                                    }
                        }

                        //    lastly for the segment, the status
                        inStream.read((char
*)&(gnSegments[i].status), sizeof(unsigned char));
                  }

                  //    read in the number of sn segments
                  inStream.read((char *)&numSnSegments,
sizeof(numSnSegments));

                  if (inStream)     {
                        //    do the same thing for the surname
segments
                        for (i = 0; i < numSnSegments; i++) {
                              //    first, read in the offset
(into the snSegs area) of the segString
                              inStream.read((char *)&segOffset,
sizeof(unsigned short));

                              if (inStream)     {
                                    //    update the pointer
                                    if (segOffset == (unsigned
short int)-1)
                                          snSegments[i].segString
```

```
= "";
                                                    else
                                                          snSegments[i].segString
= snSegString + segOffset;
                                              }

                                              //    now, read in the number of
TAQs
                                              inStream.read((char
*)&(snSegments[i].numTAQs), sizeof(unsigned char));

                                              if (inStream)     {
                                                    //    now read in the TAQs.
These are stored just like the segment,
                                                    //    such that the leading
element is the offset of the segString.
                                                    for (int j = 0; j <
snSegments[i].numTAQs; j++)   {
                                                          //    first, the offset
                                                          inStream.read((char
*)&segOffset, sizeof(unsigned short));
                                                          snSegments[i].taqList[j]
.segString = snSegString + segOffset;

                                                          //    next, the TAQ
action
                                                          inStream.read((char
*)&(snSegments[i].taqList[j].taqAction), sizeof(char));

                                                          //    lastly, the TAQ
type
                                                          inStream.read((char
*)&(snSegments[i].taqList[j].taqType), sizeof(char));
                                                    }
                                              }
                                              //    lastly for the segment, the
status
                                              inStream.read((char
*)&(snSegments[i].status), sizeof(unsigned char));
                                        }
                                  }
                            }
                            else  {
                                  //    there was some sort of problem reading in the
snLen
                                  //    so set nameStorage to NULL so we don't try to
free it.
                                  nameStorage = NULL;
                            }
                      }
                      else  {
                            //    there was some sort of problem reading in the gnLen
                            //    so set nameStorage to NULL so we don't try to free it.
                            nameStorage = NULL;
                      }
}


NHNameData::~NHNameData()
{
```

```
      if (nameStorage != NULL)
            free(nameStorage);
}


bool  NHNameData::archiveData(ostream &outStream)
{
      bool  rc = true;

      //    save the given name len and surname len
      outStream.write((char *)&allocedGnLen, sizeof(allocedGnLen));
      outStream.write((char *)&allocedSnLen, sizeof(allocedSnLen));

      //    save the actual name data
      outStream.write(nameStorage, variableNameAllocSize);

      //    write out the number of gn segments
      outStream.write((char *)&numGnSegments, sizeof(numGnSegments));

      //    write out however many gn segments we need to
      //    for each one, we first write out the offset (into the
      //    gnSegs area) of the segString member.
      //    Then, we write out the numTAQs,
      //    then, the TAQs themselves
      //    then, the status.
      unsigned short int      segOffset;
      for (int i = 0; i < numGnSegments; i++)   {
            //    first, the segString offset.  Check for a null
segment, and code it
            //    as -1.
            if (gnSegments[i].segString[0] == EOS)
                  segOffset = (unsigned short int)-1;
            else
                  segOffset = (unsigned short
int)(gnSegments[i].segString - gnSegString);
            outStream.write((char *)&segOffset, sizeof(unsigned short
int));

            //    next, number of TAQs
            outStream.write((char *)&(gnSegments[i].numTAQs),
sizeof(unsigned char));

            //    next, the TAQs.  We do a similar thing here, where we
first write out
            //    the offset of the taq's segString.
            for (int j = 0; j < gnSegments[i].numTAQs; j++) {
                  //    first, the segString offset
                  segOffset = (unsigned short
int)(gnSegments[i].taqList[j].segString - gnSegString);
                  outStream.write((char *)&segOffset, sizeof(unsigned
short int));

                  //    next, the TAQ action
                  outStream.write((char
*)&(gnSegments[i].taqList[j].taqAction), sizeof(char));

                  //    lastly, the TAQ type
                  outStream.write((char
*)&(gnSegments[i].taqList[j].taqType), sizeof(char));
            }
```

```
            //    lastly for the segment, the status
            outStream.write((char *)&(gnSegments[i].status),
sizeof(unsigned char));
      }

      //    write out the number of sn segments
      outStream.write((char *)&numSnSegments, sizeof(numSnSegments));

      //    do the same thing for the sn segments
      for (i = 0; i < numSnSegments; i++) {
            //    first, the segString offset
            if (snSegments[i].segString[0] == EOS)
                  segOffset = (unsigned short int)-1;
            else
                  segOffset = (unsigned short
int)(snSegments[i].segString - snSegString);
            outStream.write((char *)&segOffset, sizeof(unsigned short
int));

            //    next, number of TAQs
            outStream.write((char *)&(snSegments[i].numTAQs),
sizeof(unsigned char));

            //    next, the TAQs.  We do a similar thing here, where we
first write out
            //    the offset of the taq's segString.
            for (int j = 0; j < snSegments[i].numTAQs; j++) {
                  //    first, the segString offset
                  segOffset = (unsigned short
int)(snSegments[i].taqList[j].segString - snSegString);
                  outStream.write((char *)&segOffset, sizeof(unsigned
short int));

                  //    next, the TAQ action
                  outStream.write((char
*)&(snSegments[i].taqList[j].taqAction), sizeof(char));

                  //    lastly, the TAQ type
                  outStream.write((char
*)&(snSegments[i].taqList[j].taqType), sizeof(char));
            }

            //    lastly for the segment, the status
            outStream.write((char *)&(snSegments[i].status),
sizeof(unsigned char));
      }

      return rc;
}



//    go through the different name fields, and remove noise characters
//    Also, convert any segDelimChars to spaces
//    Also, split the name fields into segments
void  NHNameData::preprocessName(char *noiseChars, char *segDelimChars)
{
      char  *inChar;
      char  *outChar;
      int         i;
```

```
      numGnSegments = 0;
      inChar = gn;
      outChar = gnSegString;
      *outChar = EOS;
      gnSegments[0].segString = outChar;
      while ((*inChar != EOS) && (numGnSegments <
NH_MAX_SEGS_BEFORE_TAQ))      {
            //    if this is a noise character, just move on to the next
one in the name
            if (strchr(noiseChars, *inChar))
                  inChar++;
            else  {
                  if (strchr(segDelimChars, *inChar)) {
                        //    make sure this is not the next in a series
of white spaces
                        if (*(gnSegments[numGnSegments].segString) !=
EOS)  {
                              //    note that we know the segment.
                              gnSegments[numGnSegments].status =
NH_NAME_FIELD_STATUS_KNOWN;
                              *outChar = EOS;          //    terminate
the last segment
                              numGnSegments++;  //    look at next
segment
                              //    make sure we are not past the max
number of segments
                              if (numGnSegments >=
NH_MAX_SEGS_BEFORE_TAQ)
                                    break;
                              inChar++;                              //
look at next char in name
                              outChar++;                        //    point
to next available space in the output array
                              gnSegments[numGnSegments].segString =
outChar;
                              *outChar = EOS;          // init the new
segment
                        }
                        else        //    this is a segDelim char, and
so was the last one.
                              inChar++;                //    so just
ignore it, and move on
                  }
                  else  {
                        //    just a regular character, so add it to the
segment we are
                        //    working on currently
                        *outChar = toupper(*inChar);
                        outChar++;                        //    write to
next character in segment next time.
                        inChar++;                              //    look
at next char in name
                  }
            }
      }
      //    if we get here, it is because we reached the end of the gn
string.
      //    If we were in the middle of building a name segment, we
should
      //    terminate the segment and increase the number of segments we
```

```
have
      if ((numGnSegments < NH_MAX_SEGS_BEFORE_TAQ) &&
                  (*(gnSegments[numGnSegments].segString) !=
EOS)) {
            gnSegments[numGnSegments].status =
NH_NAME_FIELD_STATUS_KNOWN;
            *outChar = EOS;         //    terminate the last segment
            numGnSegments++;  //    look at next segment
      }

      //    now do the surname
      numSnSegments = 0;
      inChar = sn;
      outChar = snSegString;
      *outChar = EOS;
      snSegments[0].segString = outChar;
      while ((*inChar != EOS) && (numSnSegments <
NH_MAX_SEGS_BEFORE_TAQ))      {
            //    if this is a noise character, just move on to the next
one in the name
            if (strchr(noiseChars, *inChar))
                  inChar++;
            else  {
                  if (strchr(segDelimChars, *inChar)) {
                        //    make sure this is not the next in a series
of white spaces
                        if (*(snSegments[numSnSegments].segString) !=
EOS)  {
                              snSegments[numSnSegments].status =
NH_NAME_FIELD_STATUS_KNOWN;
                              *outChar = EOS;         //    terminate
the last segment
                              numSnSegments++;  //    look at next
segment
                              //    make sure we are not past the max
number of segments
                              if (numSnSegments >=
NH_MAX_SEGS_BEFORE_TAQ)
                                    break;
                              inChar++;                        //
look at next char in name
                              outChar++;                  //    point
to next available space in the output array
                              snSegments[numSnSegments].segString =
outChar;
                              *outChar = EOS;         // init the new
segment
                        }
                        else        //    this is a segDelim char, and
so was the last one.
                              inChar++;               //    so just
ignore it, and move on
                  }
                  else  {
                        //    just a regular character, so add it to the
segment we are
                        //    working on currently
                        *outChar = toupper(*inChar);
                        outChar++;                  //    write to
next character in segment next time.
                        inChar++;                        //    look
```

```
at next char in name
                }
            }
      }
      //    if we get here, it is because we reached the end of the sn
string.
      //    If we were in the middle of building a name segment, we
should
      //    terminate the segment and increase the number of segments we
have
      if ((numSnSegments < NH_MAX_SEGS_BEFORE_TAQ) &&
                  (*(snSegments[numSnSegments].segString) !=
EOS)) {
            snSegments[numSnSegments].status =
NH_NAME_FIELD_STATUS_KNOWN;
            *outChar = EOS;          //    terminate the last segment
            numSnSegments++;  //    look at next segment
      }

      //    now see if there are any segments at all
      //    in the fields.  If not, we should create a
      //    single blank segment, and mark its status as
      //    unknown.  If there are segments, we need to check for the
      //    special values NFN, NLN, NMN, FNU, LNU, MNU.  If we find
these,
      //    blank out the segment, and set the status
      //    appropriately.
      //    When a name field has more than one segment, but still
      //    specifies one of these values, we still blank it out,
      //    but we keep the segment as a blank segment.  Although the
      //    digraph score for this segment will be largely determined by
      //    the UNKNOWN or NONE parameter, it still gets treated as a
      //    segment in that oops and anchor val can be applied, and
      //    it still gets sent to best score.
      //    We do not currently look across name fields for these
markers.
      //    That is, we look for NFN, NMN, FNU. MNU in the given name
field
      //    and we look for NLN and LNU in the surname field.
      //    ??? Future versions may look across name fields.

      if (numGnSegments == 0) {
            numGnSegments = 1;
            gnSegments[0].segString = "";
            gnSegments[0].status = NH_NAME_FIELD_STATUS_UNKNOWN;
      }
      else if (nameParms->getCheckGnUnknowns()) {
            for (i = 0; i < numGnSegments; i++)       {
                  if (!strcmp(gnSegments[i].segString, "NFN"))    {
                        gnSegments[i].segString[0] = EOS;
                        gnSegments[i].status =
NH_NAME_FIELD_STATUS_NON_EXISTANT;
                  }     else if     (!strcmp(gnSegments[i].segString,
"FNU")){
                        gnSegments[i].segString[0] = EOS;
                        gnSegments[i].status =
NH_NAME_FIELD_STATUS_UNKNOWN;
                  }     else if     (!strcmp(gnSegments[i].segString,
"NMN")){
                        gnSegments[i].segString[0] = EOS;
                        gnSegments[i].status =
```

```
NH_NAME_FIELD_STATUS_NON_EXISTANT;
                }       else if     (!strcmp(gnSegments[i].segString,
"MNU")){
                        gnSegments[i].segString[0] = EOS;
                        gnSegments[i].status =
NH_NAME_FIELD_STATUS_UNKNOWN;
                }
            }
        }

        //    now the sn segs
        if (numSnSegments == 0) {
            numSnSegments = 1;
            snSegments[0].segString = "";
            snSegments[0].status = NH_NAME_FIELD_STATUS_UNKNOWN;
        }
        else if (nameParms->getCheckSnUnknowns()) {
            for (i = 0; i < numSnSegments; i++)       {
                if    (!strcmp(snSegments[i].segString, "NLN")){
                        snSegments[i].segString[0] = EOS;
                        snSegments[i].status =
NH_NAME_FIELD_STATUS_NON_EXISTANT;
                }     else if     (!strcmp(snSegments[i].segString,
"LNU"))     {
                        snSegments[i].segString[0] = EOS;
                        snSegments[i].status =
NH_NAME_FIELD_STATUS_UNKNOWN;
                }
            }
        }
}


//    function to go through the segments and for each one, see if
//    it is a TAQ value.  If so, we associate the TAQ with the previous
//    or following segment, depending on its type (i.e. prefix, suffix,
etc).
//    When we store the TAQ, we also store the action associated with
//    the TAQ (currently DELETE or DISREGARD), since this information
//    will be required to determine how to adjust the base segment score
//
//    Deciding which segment to associate a TAQ with can get pretty
//    hairy, especially when mulitple TAQs can be in a name field
//    consecutively.  We use the Following rules for single TAQ values:
//
//    TAQ Type                Segment to Associate with
//
//    Prefix                        next segment
//    Suffix                        previous segment
//    Infix                         Not supported yet
//    Title                         next segment
//    Qualifier               previous segment
//
//    These are the basic rules for figuring out which segment to
associate
//    TAQs with:
//
//    -     Any TAQ segments before the first Name segment are
associated with
//          the first name segment
```

```
//
//    -     Any TAQ segments after the last Name segment are associated
with
//          the last Name segment
//
//    -     For TAQs that are surrounded by Name segments :
//
//          -     All TAQs between a Name segment (on the left) and a
suffix (qualifier)
//                (on the right) are associated with the Name Segment.
//
//          -     All TAQs not fitting the above are assoicated with the
Name segment
//                they proceed.
//
void  NHNameData::processTAQValues(NHTAQTable *taqTable)
{
      //    NHTAQAction             taqAction;
      int                                       i;
      NH_TAQRecordPtr   tempTAQList[NH_MAX_TAQS_PER_SEGMENT];
//    temp list of TAQs found
      int                                       tempTAQSegIndex;  //
temp index for the tempTaqList
      NH_TAQRecordPtr   tempTAQRecordPtr; //    pointer to structure for
a TAQ record
      int                                       numTempTAQSegs;
//    how many TAQs did we find
      int                                       segIndex;
            //    which segment are we looking at
      int                                       lastPrefixIndex;  //
index of last prefix like segment we got
      int                                       lastSuffixIndex;  //
index of last suffix like segment we got
      int                                       lastNameIndex;
//    index of last non-TAQ segment we got
      int                                       nameSegmentTaqListIndex;
            //    where to put taqs in a name segments taq list
      char                                    *primaryCultureCode =
nameParms->primaryCultureCode;
      char                                    *secondaryCultureCode =
nameParms->secondaryCultureCode;

      //    clear out the TAQ counts for each segment.
      //    This is important because the TAQ segments are not
initalized
      //    if they are not filled in.
      for (i = 0; i < numGnSegments; i++)
            gnSegments[i].numTAQs = 0;

      if    (nameParms->getSeparateGnTaqs() == true)  {
            //    init some variables
            segIndex = 0;
            numTempTAQSegs = 0;

            //    Start out by looking for TAQs at the start of the name
field,
            //    before any name segments.
            //    while there are TAQ values at the start of the gn
            //    get their associated TAQ record and place that in
            //    a temporary list.
            while (segIndex < numGnSegments)    {
```

```
                  tempTAQRecordPtr = taqTable-
>getTAQSegment(gnSegments[segIndex].segString,


      primaryCultureCode,


      secondaryCultureCode);
                  if (tempTAQRecordPtr != NULL) {
                        //    make sure we are not past our space for
TAQs in the temp list
                        //    This would happen if a name field started
out with tons of TAQs
                        if (segIndex < NH_MAX_TAQS_PER_SEGMENT)   {
                              tempTAQList[numTempTAQSegs] =
tempTAQRecordPtr;
                              numTempTAQSegs++;
                        }
                        segIndex++;
                  }
                  else
                        break;
            }

            //    as long as we found a non-TAQ segment
            if (segIndex < numGnSegments) {
                  //    fill up the taqList for the first Name Segment
with
                  //    each of the leading TAQs we found.  If we found
no TAQs above,
                  //    numTempTAQSegs will be 0, so we wont even enter
into the loop.
                  //    Also, since we resticted the loop above, we are
guaranteed to
                  //    not exceed our space for TAQs for a single
segment.
                  for (i = 0; i < numTempTAQSegs; i++)      {
                        gnSegments[segIndex].taqList[i].segString =
gnSegments[i].segString;
                        gnSegments[segIndex].taqList[i].taqAction =
tempTAQList[i]->gnAction;
                        gnSegments[segIndex].taqList[i].taqType =
tempTAQList[i]->taqType;
                        gnSegments[segIndex].numTAQs += 1;
                  }

                  //    now move all the segments back starting with
first name segment
                  //    ousting the leading TAQs.  If we found that the
first segment
                  //    was a name segment, we do not need to move
anything.
                  if (segIndex != 0)      {
                        for (i = segIndex; i < numGnSegments;
i++)  {
                              gnSegments[i - segIndex] = gnSegments[i];
                        }
                        //    note that we now have less segments, since
we removed some segments
                        //    that were TAQ values
                        numGnSegments -= segIndex;
```

```
                    //    also, set the segIndex to 0, since we are
now back at the begining
                    segIndex = 0;
                }

                //    now start looking at the remaining segments
                //    along the way, we must keep track of
                //          -     the index of the last Name segment
we found (start out as 0, since we backed it up to 0)
                //          -     the index of the last "suffix-like"
TAQ we found      (starts out as -1, since all TAQs were tacked onto seg
0)
                //          -     the index of the last "prefix-like"
TAQ we found      (starts out as -1, since all TAQs were tacked onto seg
0)
                //
                //    If we get a:
                //          Name:
                //                - associate everything between the
lastNameIndex + 1 and the
                //                      lastSuffixIndex with
gnSegment[lastNameIndex};
                //                -     associate everything between
the lastPrefixIndex and
                //                      segIndex - 1 with this name
segment.
                //                -     move everything back to oust
the TAQ values from the gnSegment array
                //                -     mark the new lastNameIndex
(lastNameIndex = segIndex;)
                //                -     adjust numGnSegments for how
many TAQs we ousted
                //          "Suffix Like"
                //                lastPrefixIndex = -
1                 //    previous prefix now considered a suffix
                //                lastSuffixIndex = segIndex
                //          "Prefix Like"
                //                lastPrefixIndex =
segIndex
                //          End of Segments
                //                - associate everything between the
lastNameIndex + 1 and segIndex
                //                      with gnSegment[lastNameIndex];
                //                -     adjust numGnSegments for how
many TAQs we had at end
                //
                //    Note that we do not do any storing of anything
until we either reach the
                //    end of the sements, or get a non-taq segment.
                //
                //    Also, as we read TAQ segments, we store a
pointer to their retrieved
                //    structure in a list.  We do this because we must
read ahead before
                //    we can store a TAQs relevant info (type, action)
as being associated
                //    with a segment, and we do not want to have to
look up the TAQ info twice.
```

```
                numTempTAQSegs = 0;
                lastPrefixIndex = -1;
                lastSuffixIndex = -1;
                lastNameIndex = segIndex;
                segIndex++;                    //    look at the next segment
                while (segIndex < numGnSegments)    {
                    tempTAQRecordPtr = taqTable-
>getTAQSegment(gnSegments[segIndex].segString,


            primaryCultureCode,


            secondaryCultureCode);
                    if (tempTAQRecordPtr == NULL) {
                        //    segment is not a TAQ value

                        //    do an initial check to make sure we
actually got one or more TAQs.
                        //    if not, all we really have to do is
just reflect the new value for
                        //    lastNameIndex.
                        if (numTempTAQSegs > 0) {
                            //    so associate all taqs between
the previous Name segment and
                            //    the last suffix with the
previous Name Segment.  Since lastSuffixIndex
                            //    may be -1 (if there we not
suffixes), we may not even enter this for loop.

                            //    this variable is necessary
because the segment at lastNameIndex
                            //    might already have TAQs stored
in its taqList (due to prefixes).
                            //    We must keep track of where
the next available place in that list is.
                            nameSegmentTaqListIndex =
gnSegments[lastNameIndex].numTAQs;
                            tempTAQSegIndex = 0;
                            for (i = lastNameIndex + 1; (i <=
lastSuffixIndex) && (nameSegmentTaqListIndex < NH_MAX_TAQS_PER_SEGMENT);
i++)  {
                                gnSegments[lastNameIndex].taqL
ist[nameSegmentTaqListIndex].segString = gnSegments[i].segString;
                                gnSegments[lastNameIndex].taqL
ist[nameSegmentTaqListIndex].taqAction = tempTAQList[tempTAQSegIndex]-
>gnAction;
                                gnSegments[lastNameIndex].taqL
ist[nameSegmentTaqListIndex].taqType = tempTAQList[tempTAQSegIndex]-
>taqType;
                                tempTAQSegIndex++;
                                nameSegmentTaqListIndex++;
                                gnSegments[lastNameIndex].numT
AQs += 1;
                            }

                            //    associate everything at or
past the previous prefix(s) with the name
                            //    segment we just found.  Again,
since there may not have been any
                            //    prefixes, we might not even
```

```
enter this for loop
                                        if (lastPrefixIndex != -1)    {
                                              for (i = lastPrefixIndex; (i <
segIndex) && (tempTAQSegIndex < NH_MAX_TAQS_PER_SEGMENT); i++)    {
                                                    gnSegments[segIndex].taq
List[i - lastPrefixIndex].segString = gnSegments[i].segString;
                                                    gnSegments[segIndex].taq
List[i - lastPrefixIndex].taqAction = tempTAQList[tempTAQSegIndex]-
>gnAction;
                                                    gnSegments[segIndex].taq
List[i - lastPrefixIndex].taqType = tempTAQList[tempTAQSegIndex]-
>taqType;
                                                    tempTAQSegIndex++;
                                                    gnSegments[segIndex].num
TAQs += 1;
                                              }
                                        }

                                        //    now move all the segments back
starting with this segment and
                                        //    ending with the last segment.
We move them back to the first
                                        //    segment after the previous
Name segment, which is numTempTAQSegs places
                                        for (i = segIndex; i <
numGnSegments; i++)     {
                                              gnSegments[i - numTempTAQSegs]
= gnSegments[i];
                                        }

                                        //for (i = lastNameIndex + 1; i <
numGnSegments; i++)     {
                                        //    gnSegments[i] = gnSegments[i +
numTempTAQSegs];
                                        //}

                                        numGnSegments -=
numTempTAQSegs;         //    we not have less segments, since we got


//    rid of some TAQs
                                        segIndex -=
numTempTAQSegs;                               //    move our pointer back
too
                                        numTempTAQSegs =
0;                                                  //    clear out
the temp segment array
                                  }
                                  lastNameIndex =
segIndex;                                     //    mark the new
lastNameIndex

                            }
                            else  {
                                  if ((tempTAQRecordPtr->taqType == 'P') ||
(tempTAQRecordPtr->taqType == 'T')) {
                                        //    got a prefix or a title
                                        tempTAQList[numTempTAQSegs] =
tempTAQRecordPtr;
                                        numTempTAQSegs++;
                                        //    only set the prefix index if
```

```
we do not have one on record.
                                    //    otherwise, we will only get
the right most prefix in a string
                                    //    of consecutive prefixes.
                                    if (lastPrefixIndex == -1)
                                          lastPrefixIndex = segIndex;
                              }
                              else  {
                                    //    must be a suffix or qualifier
                                    tempTAQList[numTempTAQSegs] =
tempTAQRecordPtr;
                                    numTempTAQSegs++;
                                    lastPrefixIndex = -
1;                  //    any previous prefixes now considered a suffix
                                    lastSuffixIndex = segIndex;
                              }
                        }
                        segIndex++;                 //    look at next
segment
                  }

                  //    now we are at the end of all segments, so make
sure that any
                  //    TAQs that were trailing get associated with the
last name segment.

                  //    do an initial check to make sure we actually got
one or more TAQs.
                  //    if not, all we really have to do is just reflect
the new value for
                  //    lastNameIndex.
                  if (numTempTAQSegs > 0) {
                        //    associate all the stored taqs with the
last name segment.
                        //    in the loop below:
                        //          i is the index into the gnSegments
list for the TAQ string we are copying
                        //          tempTAQSegIndex is the index into
the tempTAQList for the saved TAQ info
                        //          lastNameIndex is the index into the
gnSegments for the name getting
                        //                the TAQs associated with it.
                        //          gnSegmentTaqListIndex is the index
into the taqList for the name getting
                        //                the TAQs associated with it.
                        //
                        //    We must be careful that we do not
overwrite any TAQs already associated with
                        //    the name (from prefixes).  For this
reason, we use separate indexes for the
                        //    tempTAQList and the gnSegments' taqList.

                        nameSegmentTaqListIndex =
gnSegments[lastNameIndex].numTAQs;
                        tempTAQSegIndex = 0;
                        for (i = lastNameIndex + 1; (i < numGnSegments)
&& (nameSegmentTaqListIndex < NH_MAX_TAQS_PER_SEGMENT); i++)      {
                              gnSegments[lastNameIndex].taqList[nameSegm
entTaqListIndex].segString = gnSegments[i].segString;
                              gnSegments[lastNameIndex].taqList[nameSegm
entTaqListIndex].taqAction = tempTAQList[tempTAQSegIndex]->gnAction;
```

```
                                    gnSegments[lastNameIndex].taqList[nameSegm
entTaqListIndex].taqType = tempTAQList[tempTAQSegIndex]->taqType;
                                    tempTAQSegIndex++;
                                    nameSegmentTaqListIndex++;
                                    gnSegments[lastNameIndex].numTAQs += 1;
                              }

                              //    now we can just chop off all the TAQ
segments by reducing numGnSegments.
                              numGnSegments -= numTempTAQSegs;
                        }

                  }
                  else  {
                        //    we did not get any Non-TAQ segments.  Move all
the segments to the TAQ
                        //    list for the first segment, create a single
segment, and set its string
                        //    value to "".
                        gnSegments[0].numTAQs = 0;    //    set this in case
there were no TAQs (empty string)

                                    //    In that case, we would not have
cleared it out orignally
                        for (i = 0; i < numTempTAQSegs; i++)      {
                              gnSegments[0].taqList[i].segString =
gnSegments[i].segString;
                              gnSegments[0].taqList[i].taqAction =
tempTAQList[i]->gnAction;
                              gnSegments[0].taqList[i].taqType =
tempTAQList[i]->taqType;
                              gnSegments[0].numTAQs += 1;
                        }
                        numGnSegments = 1;
                        gnSegments[0].segString = "";
                        gnSegments[0].status = NH_NAME_FIELD_STATUS_UNKNOWN;
                  }
            }

            //    as a last step, we must make sure that the number of
gnSegments is
            //    now no greater than NH_MAX_SEGS_AFTER_TAQ.  We just ignore
any segments
            //    after the max.
            if (numGnSegments > NH_MAX_SEGS_AFTER_TAQ)
                  numGnSegments = NH_MAX_SEGS_AFTER_TAQ;


            //    clear out the TAQ counts for each segment.
            //    This is important because the TAQ segments are not
initalized
            //    if they are not filled in.
            for (i = 0; i < numSnSegments; i++)
                  snSegments[i].numTAQs = 0;

            //    Now do the SN segments
            if    (nameParms->getSeparateGnTaqs() == true)  {
                  //    init some variables
                  segIndex = 0;
                  numTempTAQSegs = 0;
```

```
            //    Start out by looking for TAQs at the start of the name
field,
            //    before any name segments.
            //    while there are TAQ values at the start of the sn
            //    get their associated TAQ record and place that in
            //    a temporary list.
            while (segIndex < numSnSegments)    {
                  tempTAQRecordPtr = taqTable-
>getTAQSegment(snSegments[segIndex].segString,


      primaryCultureCode,


      secondaryCultureCode);
                  if (tempTAQRecordPtr != NULL) {
                        //    make sure we are not past our space for
TAQs in the temp list
                        //    This would happen if a name field started
out with tons of TAQs
                        if (segIndex < NH_MAX_TAQS_PER_SEGMENT)    {
                              tempTAQList[numTempTAQSegs] =
tempTAQRecordPtr;
                              numTempTAQSegs++;
                        }
                        segIndex++;
                  }
                  else
                        break;
            }

            //    as long as we found a non-TAQ segment
            if (segIndex < numSnSegments) {
                  //    fill up the taqList for the first Name Segment
with
                  //    each of the leading TAQs we found.  If we found
no TAQs above,
                  //    numTempTAQSegs will be 0, so we wont even enter
into the loop.
                  //    Also, since we resticted the loop above, we are
guaranteed to
                  //    not exceed our space for TAQs for a single
segment.
                  for (i = 0; i < numTempTAQSegs; i++)      {
                        snSegments[segIndex].taqList[i].segString =
snSegments[i].segString;
                        snSegments[segIndex].taqList[i].taqAction =
tempTAQList[i]->snAction;
                        snSegments[segIndex].taqList[i].taqType =
tempTAQList[i]->taqType;
                        snSegments[segIndex].numTAQs += 1;
                  }

                  //    now move all the segments back starting with
first name segment
                  //    ousting the leading TAQs.  If we found that the
first segment
                  //    was a name segment, we do not need to move
anything.
                  if (segIndex != 0)      {
                        for (i = segIndex; i < numSnSegments;
```

```
i++)  {
                        snSegments[i - segIndex] = snSegments[i];
                    }
                    //    note that we now have less segments, since
we removed some segments
                    //    that were TAQ values
                    numSnSegments -= segIndex;

                    //    also, set the segIndex to 0, since we are
now back at the begining
                    segIndex = 0;
                }

                //    now start looking at the remaining segments
                //    along the way, we must keep track of
                //          -     the index of the last Name segment
we found (start out as 0, since we backed it up to 0)
                //          -     the index of the last "suffix-like"
TAQ we found      (starts out as -1, since all TAQs were tacked onto seg
0)
                //          -     the index of the last "prefix-like"
TAQ we found      (starts out as -1, since all TAQs were tacked onto seg
0)
                //
                //    If we get a:
                //          Name:
                //                - associate everything between the
lastNameIndex + 1 and the
                //                      lastSuffixIndex with
snSegment[lastNameIndex];
                //                -     associate everything between
the lastPrefixIndex and
                //                      segIndex - 1 with this name
segment.
                //                -     move everything back to oust
the TAQ values from the snSegment array
                //                -     mark the new lastNameIndex
(lastNameIndex = segIndex;)
                //                -     adjust numSnSegments for how
many TAQs we ousted
                //          "Suffix Like"
                //                lastPrefixIndex = -
1               //    previous prefix now considered a suffix
                //                lastSuffixIndex = segIndex
                //          "Prefix Like"
                //                lastPrefixIndex =
segIndex
                //          End of Segments
                //                - associate everything between the
lastNameIndex + 1 and segIndex
                //                      with snSegment[lastNameIndex];
                //                -     adjust numSnSegments for how
many TAQs we had at end
                //
                //    Note that we do not do any storing of anything
until we either reach the
                //    end of the sements, or get a non-taq segment.
                //
                //    Also, as we read TAQ segments, we store a
pointer to their retrieved
                //    structure in a list.  We do this because we must
```

```
read ahead before
                //    we can store a TAQs relevant info (type, action)
as being associated
                //    with a segment, and we do not want to have to
look up the TAQ info twice.


                numTempTAQSegs = 0;
                lastPrefixIndex = -1;
                lastSuffixIndex = -1;
                lastNameIndex = segIndex;
                segIndex++;             //    look at the next segment
                while (segIndex < numSnSegments)    {
                      tempTAQRecordPtr = taqTable-
>getTAQSegment(snSegments[segIndex].segString,


            primaryCultureCode,


            secondaryCultureCode);
                      if (tempTAQRecordPtr == NULL) {
                            //    segment is not a TAQ value

                            //    do an initial check to make sure we
actually got one or more TAQs.
                            //    if not, all we really have to do is
just reflect the new value for
                            //    lastNameIndex.
                            if (numTempTAQSegs > 0) {
                                  //    so associate all taqs between
the previous Name segment and
                                  //    the last suffix with the
previous Name Segment.  Since lastSuffixIndex
                                  //    may be -1 (if there we not
suffixes), we may not even enter this for loop.

                                  //    this variable is necessary
because the segment at lastNameIndex
                                  //    might already have TAQs stored
in its taqList (due to prefixes).
                                  //    We must keep track of where
the next available place in that list is.
                                  nameSegmentTaqListIndex =
snSegments[lastNameIndex].numTAQs;
                                  tempTAQSegIndex = 0;
                                  for (i = lastNameIndex + 1; (i <=
lastSuffixIndex) && (nameSegmentTaqListIndex < NH_MAX_TAQS_PER_SEGMENT);
i++)  {
                                        snSegments[lastNameIndex].taqL
ist[nameSegmentTaqListIndex].segString = snSegments[i].segString;
                                        snSegments[lastNameIndex].taqL
ist[nameSegmentTaqListIndex].taqAction = tempTAQList[tempTAQSegIndex]-
>snAction;
                                        snSegments[lastNameIndex].taqL
ist[nameSegmentTaqListIndex].taqType = tempTAQList[tempTAQSegIndex]-
>taqType;
                                        tempTAQSegIndex++;
                                        nameSegmentTaqListIndex++;
                                        snSegments[lastNameIndex].numT

AQs += 1;
```

```
                                    }

                                    //    associate everything at or
past the previous prefix(s) with the name
                                    //    segment we just found.  Again,
since there may not have been any
                                    //    prefixes, we might not even
enter this for loop
                                    if (lastPrefixIndex != -1)    {
                                          for (i = lastPrefixIndex; (i <
segIndex) && (tempTAQSegIndex < NH_MAX_TAQS_PER_SEGMENT); i++)    {
                                                snSegments[segIndex].taq
List[i - lastPrefixIndex].segString = snSegments[i].segString;
                                                snSegments[segIndex].taq
List[i - lastPrefixIndex].taqAction = tempTAQList[tempTAQSegIndex]-
>snAction;
                                                snSegments[segIndex].taq
List[i - lastPrefixIndex].taqType = tempTAQList[tempTAQSegIndex]-
>taqType;
                                                tempTAQSegIndex++;
                                                snSegments[segIndex].num
TAQs += 1;
                                          }
                                    }

                                    //    now move all the segments back
starting with this segment and
                                    //    ending with the last segment.
We move them back to the first
                                    //    segment after the previous
Name segment, which is numTempTAQSegs places
                                    for (i = segIndex; i <
numSnSegments; i++)     {
                                          snSegments[i - numTempTAQSegs]
= snSegments[i];
                                    }

                                    numSnSegments -=
numTempTAQSegs;         //    we not have less segments, since we got


//    rid of some TAQs
                                    segIndex -=
numTempTAQSegs;                           //    move our pointer back
too
                                    numTempTAQSegs =
0;                                                  //    clear out
the temp segment array
                              }
                              lastNameIndex =
segIndex;                                 //    mark the new
lastNameIndex

                        }
                        else  {
                              if ((tempTAQRecordPtr->taqType == 'P') ||
(tempTAQRecordPtr->taqType == 'T')) {
                                    //    got a prefix or a title
                                    tempTAQList[numTempTAQSegs] =
tempTAQRecordPtr;
                                    numTempTAQSegs++;
```

```
                                    //    only set the prefix index if
we do not have one on record.
                                    //    otherwise, we will only get
the right most prefix in a string
                                    //    of consecutive prefixes.
                                    if (lastPrefixIndex == -1)
                                          lastPrefixIndex = segIndex;
                              }
                              else  {
                                    //    must be a suffix or qualifier
                                    tempTAQList[numTempTAQSegs] =
tempTAQRecordPtr;
                                    numTempTAQSegs++;
                                    lastPrefixIndex = -
1;                  //    any previous prefixes now considered a suffix
                                    lastSuffixIndex = segIndex;
                              }
                        }
                        segIndex++;             //    look at next
segment
                  }

                  //    now we are at the end of all segments, so make
sure that any
                  //    TAQs that were trailing get associated with the
last name segment.

                  //    do an initial check to make sure we actually got
one or more TAQs.
                  //    if not, all we really have to do is just reflect
the new value for
                  //    lastNameIndex.
                  if (numTempTAQSegs > 0) {
                        //    associate all the stored taqs with the
last name segment.
                        //    in the loop below:
                        //          i is the index into the snSegments
list for the TAQ string we are copying
                        //          tempTAQSegIndex is the index into
the tempTAQList for the saved TAQ info
                        //          lastNameIndex is the index into the
snSegments for the name getting
                        //                the TAQs associated with it.
                        //          snSegmentTaqListIndex is the index
into the taqList for the name getting
                        //                the TAQs associated with it.
                        //
                        //    We must be careful that we do not
overwrite any TAQs already associated with
                        //    the name (from prefixes).  For this
reason, we use separate indexes for the
                        //    tempTAQList and the snSegments' taqList.

                        nameSegmentTaqListIndex =
snSegments[lastNameIndex].numTAQs;
                        tempTAQSegIndex = 0;
                        for (i = lastNameIndex + 1; (i < numSnSegments)
&& (nameSegmentTaqListIndex < NH_MAX_TAQS_PER_SEGMENT); i++)      {
                              snSegments[lastNameIndex].taqList[nameSegm
entTaqListIndex].segString = snSegments[i].segString;
                              snSegments[lastNameIndex].taqList[nameSegm
```

```
entTaqListIndex].taqAction = tempTAQList[tempTAQSegIndex]->snAction;
                              snSegments[lastNameIndex].taqList[nameSegm
entTaqListIndex].taqType = tempTAQList[tempTAQSegIndex]->taqType;
                              tempTAQSegIndex++;
                              nameSegmentTaqListIndex++;
                              snSegments[lastNameIndex].numTAQs += 1;
                        }

                        //    now we can just chop off all the TAQ
segments by reducing numSnSegments.
                        numSnSegments -= numTempTAQSegs;
                  }

            }
            else  {
                  //    we did not get any Non-TAQ segments.  Move all
the segments to the TAQ
                  //    list for the first segment, create a single
segment, and set its string
                  //    value to "".
                  snSegments[0].numTAQs = 0;    //    set this in case
there were no TAQs (empty string)

                              //    In that case, we would not have
cleared it out orignally
                  for (i = 0; i < numTempTAQSegs; i++)      {
                        snSegments[0].taqList[i].segString =
snSegments[i].segString;
                        snSegments[0].taqList[i].taqAction =
tempTAQList[i]->snAction;
                        snSegments[0].taqList[i].taqType =
tempTAQList[i]->taqType;
                        snSegments[0].numTAQs += 1;
                  }
                  numSnSegments = 1;
                  snSegments[0].segString = "";
                  snSegments[0].status = NH_NAME_FIELD_STATUS_UNKNOWN;
            }
      }

      //    as a last step, we must make sure that the number of
gnSegments is
      //    now no greater than NH_MAX_SEGS_AFTER_TAQ.  We just ignore
any segments
      //    after the max.
      if (numSnSegments > NH_MAX_SEGS_AFTER_TAQ)
            numSnSegments = NH_MAX_SEGS_AFTER_TAQ;

}



//    function to generate index keys for this name.
//    Each key includes a portion for the GN and a portion
//    for the SN.
//    We currently support two key lengths, 32 bits or 64 bits.
//    The GN length does not have to be the same as the SN length,
//    but GN keys generated must be the same length (similarly for
//    SN).  Thus the full key length could be:
//
//          64:         Both GN and SN are 32 bits
```

```
//          96:         Gn is 64, but SN is 32
//          96:         Gn is 32, but SN is 64
//          128:  Both GN and SN are 64 bits
//
//    Keys are generated by name stem segment.  The first key
//    consists of a key for the first GN segment, and a key
//    for the first SN segment.  The second key
//    consists of a key for the second GN segment, and a key
//    for the second SN segment.  When there are a differing number
//    of GN and SN segments, the final segment of the name
//    field with the fewer number of segments is repeated.
//    Thus, the number of keys generated is given by the formula:
//                max(numGnSegs, numSnSegs)
//
//    We do things this way so that a name has the same number of keys
//    for both GN and SN, and in fact we can view the two keys as one
//    contiguous key that can be passed to comparison functions as a
//    single value.
//
//    Note that we are talking about stem segments (TAQ segments have
//    been removed).
//
//    maxKeys specifies how many keys the caller can fit into
//    keyBuff.  It is up to the caller to make sure that they have
allocated
//    enough space in the keyBuff to hold maxKeys.
unsigned    char  NHNameData::genIndexKeys(int maxKeys, NHKeyWidth
gnKeyWidth,

                NHKeyWidth snKeyWidth, void *keyBuff)
{
      int   numKeysGenerated = 0;
      int gnSegIndex = 0;
      int snSegIndex = 0;
      unsigned    int   *keyPtr = (unsigned     int   *)keyBuff;


      while (numKeysGenerated < maxKeys)  {
            if ((gnSegIndex >= numGnSegments) && (snSegIndex >=
numSnSegments))
                  break;
            else  {
                  numKeysGenerated++;
                  //    make sure that if one segment is now at the end,
                  //    we stay on the last segment
                  if (gnSegIndex == numGnSegments)
                        gnSegIndex--;
                  if (snSegIndex == numSnSegments)
                        snSegIndex--;

                  if (gnKeyWidth == NH_KEY_WIDTH_32)  {
                        //    gn key length is 32
                        *keyPtr =
globalDigraphBitmapArray.get32BitKeyForToken(gnSegments[gnSegIndex].segS
tring);

                        keyPtr++;         //    move the pointer by 4
bytes
                  }
                  else  {
                        //    gn key length is 64
```

```
                        globalDigraphBitmapArray.get64BitKeyForToken(gnS
egments[gnSegIndex].segString,

            (bit_64_t *)keyPtr);
                        keyPtr += 2;            //    move the pointer
by 8 bytes
                  }

                  if (snKeyWidth == NH_KEY_WIDTH_32)  {
                        //    gn key length is 32
                        *keyPtr =
globalDigraphBitmapArray.get32BitKeyForToken(snSegments[snSegIndex].segS
tring);
                        keyPtr++;         //    move the pointer by 4
bytes
                  }
                  else  {
                        //    gn key length is 64
                        globalDigraphBitmapArray.get64BitKeyForToken(snS
egments[snSegIndex].segString,

            (bit_64_t *)keyPtr);
                        keyPtr += 2;            //    move the pointer
by 8 bytes
                  }

                  //    advance the segment indexes
                  snSegIndex++;
                  gnSegIndex++;
            }
      }
      return numKeysGenerated;
}
```

```
//    File:  NHEvalNameData.cpp
//
//    Description:
//
//          Implementation to the NHEvalNameData class.
//
//
//    History:
//
//          5/14/97           EFB         Created
//          9/1/97            EFB         Lots of changes to support
retaining segment scores in
//                                                                    best mode so
that sorting can be more detailed and accurate
//          10/31/97    EFB         Made several member functions
protected, and made performComp()
//                                                                    a friend of
NHQueryNameData.  Also changed performComp to
//                                                                    NOT delete
objects that are not passed on to the resultslist,
//                                                                    to
accomodate the new method of deleting NHEvalNameData objects.
//          11/03/97    EFB         Added a new function,
calcNameScore() and made it virtual.
//                                                                    removed
virtual from performComp.  The perform comp method
//                                                                    was too
complicated to be subclassed.  We really only want
//                                                                    callers to
be able to affect the name score and the determination
//                                                                    of
HIT/NO_HIT.  These are now the only virtual functions.  Both
//                                                                    are now
inline in the header file so the caller knows exactly
//                                                                    what is
happening in these functions if they decide to subclass
//                                                                    and
override. OOPS, I forgot compareScore(), which is also
//                                                                    virtual - we
want them to be able to change how hits are sorted.
//
//          3/02/98     EFB               Made lots of changes necessary
when I moved a bunch of
//                                                                    parameters
(the ones associated with parsing the name)
//                                                                    from the
NHCompParms class into a new class called NHNameParms.
//                                                                    and renamed
the NHCompParms class to NHCompParms.
//          3/20/98     EFB         Changed names to NH from SN


#include <string.h>
#include <stdio.h>
#include <stdlib.h>

#include    "NHEvalNameData.hpp"
#include    "NHQueryNameData.hpp"
#include    "NH_util.hpp"
#include    "NH_queens_arrays.hpp"
```

```
#include    "NHVariantTable.hpp"
#include    "NHResultsList.hpp"
#include    "NHTAQTable.hpp"
#include    "NHNameParms.hpp"


//    private, non-member function prototype
static double     NH_digraph_score(char *qSeg, int qSegLen,

char *evalSeg, int evalSegLen,
                          bool useLeftDigraphBias);

static      double      NH_best_score(int numQSegs, int numEvalSegs,
NHSegScoreMode scoreMode,
                                                                    double
scores[NH_MAX_SEGS_AFTER_TAQ][NH_MAX_SEGS_AFTER_TAQ]);

void  NH_best_score_for_highest_mode(int xDim, int yDim, double
highestScore,
                                                                    double
*bestSegScores,
                                                                    double
scores[NH_MAX_SEGS_AFTER_TAQ][NH_MAX_SEGS_AFTER_TAQ]);

static      double NH_calc_score(   SegList qSegs, int numQSegs,
                                                                    SegLis
t evalSegs, int numEvalSegs,
                                                                    SegLis
tVariants querySegmentVariants,
                                                                    char
                                    *primaryCulture,
                                                                    char
                                    *secondaryCulture,
                                                                    NHComp
Parms *compParms,
                                                                    NHName
Parms *nameParms,
                                                                    NHName
Fields nameField,
                                                                    char
*origQNameField,
                                                                    char
*origEvalNameField,
                                                                    int
*numSegsScored,
                                                                    double
*bestSegScores);

static      void  NH_apply_TAQs_to_score(double *diScore, Segment *qSeg,
Segment *evalSeg,
                        double absDelTAQFactor,
                        double absDisTAQFactor,
                        double delTAQFactor,
                        double disTAQFactor);

static      bool NH_check_compressed_name(char *qSegString, char
```

```
*evalSegString,
                                                char *compressCharsPart1,
                                                char  *compressCharsPart2);


NHEvalNameData::NHEvalNameData(NHNameParms *nParms, char *aGn, char
*aSn) :
                                                      NHNameData(nParms, aGn,
aSn)
{
      resetScores();
}


NHEvalNameData::NHEvalNameData(NHNameParms *nParms, char *aGn, char
*aSn, char *aMn) :
                                                      NHNameData(nParms, aGn,
aSn, aMn)
{
      resetScores();
}


NHEvalNameData::NHEvalNameData(NHNameParms *nParms, char *name,
NHNameFormat nameFormat)      :
                                                      NHNameData(nParms, name,
nameFormat)
{
      resetScores();
}


//    constuct an object from an archived representation in
//    a stream.
//
//    The archive is in the following order
//
//    gnLen
//    snLen
//    nameStorage
NHEvalNameData::NHEvalNameData(NHNameParms *nParms, istream &inStream) :
                                                        NHNameData(nParms,
inStream)
{
      //    read the gn, sn and name scores
      if (inStream)
            inStream.read((char *)&gnScore, sizeof(gnScore));
      if (inStream)
            inStream.read((char *)&snScore, sizeof(snScore));
      if (inStream)
            inStream.read((char *)&nameScore, sizeof(nameScore));

      //    seg differentials
      if (inStream)
            inStream.read((char *)&gnSegDifferential,
sizeof(gnSegDifferential));
      if (inStream)
            inStream.read((char *)&snSegDifferential,
sizeof(snSegDifferential));
```

```
	//	read the number of gn segs scored, and however many scores
we need	inStream.read((char *)&numGnSegsScored,
sizeof(numGnSegsScored));
	if (inStream)
		inStream.read((char *)&numGnSegsScored,
sizeof(numGnSegsScored));
	if (inStream)	{
		if (numGnSegsScored > 0)	{
			inStream.read((char *)gnSegScores, numGnSegsScored *
sizeof(double));
		}
	}

	//	read the number of sn segs scored, and however many scores
we need
	if (inStream)
		inStream.read((char *)&numSnSegsScored,
sizeof(numSnSegsScored));
	if (inStream)	{
		if (numSnSegsScored > 0)	{
			inStream.read((char *)snSegScores, numSnSegsScored *
sizeof(double));
		}
	}
}


NHEvalNameData::~NHEvalNameData()
{
}


bool	NHEvalNameData::archiveData(ostream &outStream)
{
	bool	rc = true;


	rc = NHNameData::archiveData(outStream);
	if (rc)	{
		//	read the gn, sn and name scores
		outStream.write((char *)&gnScore, sizeof(gnScore));
		outStream.write((char *)&snScore, sizeof(snScore));
		outStream.write((char *)&nameScore, sizeof(nameScore));

		//	seg differentials
		outStream.write((char *)&gnSegDifferential,
sizeof(gnSegDifferential));
		outStream.write((char *)&snSegDifferential,
sizeof(snSegDifferential));

		//	read the number of gn segs scored, and however many
scores we need	inStream.read((char *)&numGnSegsScored,
sizeof(numGnSegsScored));
		outStream.write((char *)&numGnSegsScored,
sizeof(numGnSegsScored));
		if (numGnSegsScored > 0)	{
			outStream.write((char *)gnSegScores, numGnSegsScored *
sizeof(double));
		}
```

```
            //    read the number of sn segs scored, and however many
scores we need
            outStream.write((char *)&numSnSegsScored,
sizeof(numSnSegsScored));
            if (numSnSegsScored > 0)      {
                  outStream.write((char *)snSegScores, numSnSegsScored *
sizeof(double));
            }
      }

      return rc;
}


//    note that this function is a friend of NHQueryNameData, which is
//    why we are able to access private member functions of that class.
void  inline NHEvalNameData::calcComponentScores(NHQueryNameData
*queryName)
{
      char                                    *primaryCulture = nameParms-
>primaryCultureCode;
      char                                    *secondaryCulture = nameParms-
>secondaryCultureCode;

      //    do the digraph compare and set the scores
      gnScore = NH_calc_score(queryName->gnSegments, queryName-
>numGnSegments,
                                                                  gnSegm
ents, numGnSegments,
                                                                  queryN
ame->gnSegmentVariants,
                                                                  primar
yCulture, secondaryCulture,
                                                                  compPa
rms,
                                                                  namePa
rms,
                                                                  NH_FIR
ST_NAME,
                                                                  queryN
ame->gn, gn,
                                                                  &numGn
SegsScored,
                                                                  gnSegS
cores);
      snScore = NH_calc_score(queryName->snSegments, queryName-
>numSnSegments,
                                                                  snSegm
ents, numSnSegments,
                                                                  queryN
ame->snSegmentVariants,
                                                                  primar
yCulture, secondaryCulture,
                                                                  compPa
rms,
                                                                  namePa
rms,
                                                                  NH_LAS
T_NAME,
                                                                  queryN
ame->sn, sn,
```

```
                                                                  &numSn
SegsScored,
                                                                  snSegS
cores);
}


//    note that this function is a friend of NHQueryNameData, which is
//    why we are able to access private member functions of that class.
NHReturnCode      NHEvalNameData::performComp(NHQueryNameData
*queryName,
                                                                  NHCompParms
*someCompParms)
{
      NHReturnCode            compResult;
      NHResultsList           *resultList;


      //    save the compParms so that they can be easily referenced
      //    throughout the comparison process.
      compParms = someCompParms;

      calcComponentScores(queryName);

      //    call a method to calculate the name score.
      calcNameScore();

      //    store the segments differentials, in case we get a tie
score.
      gnSegDifferential = abs(numGnSegments - queryName-
>getNumGnSegments());
      snSegDifferential = abs(numSnSegments - queryName-
>getNumSnSegments());

      //    Now call the getCompResult() function to get the return
value
      //    (i.e. was it a match?)
      compResult = getCompResult();

      //    now see if we are working with a results list
      resultList = queryName->getResultsList();
      if (resultList != NULL) {
            //    we are using a result list.  If this is a hit, add it
            //    to the result list.
            //    Otherwise, delete it
            if (compResult == NH_MATCH)   {
                  NHReturnCode            tempInsertResult;

                  //    make sure the insert works.  If so, don't mess
with
                  //    the compResult, so the comparison will be
returned
                  //    as a hit.  If there was an error, delete this
object,
                  //    and save the error code so it can be returned.
                  tempInsertResult = resultList->addHit(this);
                  if (tempInsertResult != NH_SUCCESS) {
                        compResult = tempInsertResult;
                  }
            }
```

```
	}
	return compResult;
}


//	used only when the segment mode is set to HIGHEST.
//	It compares the segment scores the were retained when
//	the name was compared to the query name.
//	We are comparing the segment scores for two (pre-scored)
//	eval names.  The comparison should find which name has
//	the "best" set of segment scores, where best is defined
//	as "the one with the highest best score".  If the best
//	score results in a tie, we move on to the second best score,
//	and so on until we find a difference, or there are no more
//	segments to compare.  Each name has variables numGnSegsScored
//	and numSnSegsScored, that tell how many segments were scored
//	in the name.  We do up to N comparisons, where N is the larger
//	of the number of segments scored in each name.  Where one name
//	has less segments scored than the other, a default value of
//	NH_DEFAULT_MISSING_SEGMENT_SCORE is assigned.  This is so that
//	a scored segment has to beat some threshold to be considered
//	better than nothing at all.
//
double	NHEvalNameData::compareSegmentScores(NHEvalNameData
*scoredName, NHNameFields nameField)
{
	double	scoreDiff;
	int		maxComparisons;
	double	*thisEvalScores;
	double	*compEvalScores;
	int		numSegsScoredForThisEval;
	int		numSegsScoredForCompEval;


	if (nameField == NH_LAST_NAME)	{
		thisEvalScores = snSegScores;
		compEvalScores = scoredName->snSegScores;
		numSegsScoredForThisEval = numSnSegsScored;
		numSegsScoredForCompEval = scoredName->numSnSegsScored;
	}
	else	{
		thisEvalScores = gnSegScores;
		compEvalScores = scoredName->gnSegScores;
		numSegsScoredForThisEval = numGnSegsScored;
		numSegsScoredForCompEval = scoredName->numGnSegsScored;
	}
	maxComparisons = numSegsScoredForThisEval >
numSegsScoredForCompEval ? numSegsScoredForThisEval :
numSegsScoredForCompEval;

	for (int i = 0; i < maxComparisons; i++)  {
		if (i >= numSegsScoredForThisEval)
			thisEvalScores[i] = NH_DEFAULT_MISSING_SEGMENT_SCORE;
		else		//	we can do an else because only one segment
can be missing, not both
			if (i >= numSegsScoredForCompEval)
				compEvalScores[i] =
NH_DEFAULT_MISSING_SEGMENT_SCORE;

		scoreDiff = compEvalScores[i] - thisEvalScores[i];
		if (scoreDiff != 0)
```

```
                break;
        }

        return scoreDiff;
}


/*************************************************************************
****/

/* NH_calc_score
   Performs a string comparison on two name fields.
       Returns a value between 0.00 and
   1.00, with 1.00 being an exact-fit

*/
double NH_calc_score(   SegList qSegs, int numQSegs,
                                                                SegLis
t evalSegs, int numEvalSegs,
                                                                SegLis
tVariants querySegmentVariants,
                                                                char
                                        *primaryCulture,
                                                                char
                                        *secondaryCulture,
                                                                NHComp
Parms *compParms,
                                                                NHName
Parms *nameParms,
                                                                NHName
Fields nameField,
                                                                char
*origQNameField,
                                                                char
*origEvalNameField,
                                                                int
*numSegsScored,
                                                                double
*bestSegScores)
{
        NHAnchorSegMode         anchorSeg;
        NHSegScoreMode          scoreMode;
        double                                  oopsFactor;
        double                                  absDelTAQFactor;
        double                                  absDisTAQFactor;
        double                                  delTAQFactor;
        double                                  disTAQFactor;
        bool                                    matchInit;
        double                                  initScore;
        double                                  initialOnInitialMatchSco
re;
        bool                                    checkVariant;
        //    double                                    variantScore;
        bool                                    leftDigraphBias;
        double                                  anchorFactor;
        double                                  nameUnknownScore;
        double                                  noNameScore;
  double                                scoresTable[NH_MAX_SEGS_AFTER_
TAQ][NH_MAX_SEGS_AFTER_TAQ];  //    scores for segment pairs
        int                                             qIndex;
        //    temp index for query segments
```

```
      int                                                evalIndex;  //
temp index for eval segments
      int                                                qSegLen;
//    hold string length of query segment
      int                                                evalSegLen; //
hold string length of eval segment
  double                                        diScore =
0.0;        //    temp score for single pair comparison
      double                                          hiScore =
0.0;        //    temp score to hold best score as we iterate,

                                                //    which lets us avoid
best_score in mode=BEST
      bool                                              areVariants;
//    temp flag to hold if the pair are variants
  double                                                  returnValue = 0.0;
      NHVariantTable                            *variantTable;
      double                                                  varScore;
      NHVarId                                                 evalSegVarId
;
      bool                                              scoreTaqs;
      double                                            compressedNameScore;
      bool                                              checkCompressedName;


      //    set some paramters based on the name field
  if (nameField == NH_LAST_NAME) {
    anchorSeg = compParms->getSnAnchorSegmentMode();
    scoreMode = compParms->getSnSegmentScoreMode();
    oopsFactor = compParms->getSnOOPSFactor();
    matchInit = compParms->getMatchSnIntial();
    initScore = compParms->getSnInitialScore();
            initialOnInitialMatchScore = compParms-
>getSnInitialOnInitialMatchScore();
    checkVariant = compParms->getUseSnVariants();
            anchorFactor = compParms->getSnAnchorFactor();
            leftDigraphBias = compParms->getUseSnLeftBias();
            nameUnknownScore = compParms->getLNUScore();
            noNameScore = compParms->getNLNScore();
            scoreTaqs = compParms->getScoreSnTAQs();
            absDelTAQFactor = compParms->getAbsDelSnTAQFactor();
            absDisTAQFactor = compParms->getAbsDisSnTAQFactor();
            delTAQFactor = compParms->getDelSnTAQFactor();
            disTAQFactor = compParms->getDisSnTAQFactor();
            compressedNameScore = compParms->getSnCompressedNameScore();
            checkCompressedName = compParms->getCheckSnCompressedName();
            variantTable = nameParms->snVariantTable;
      }
   else {
    anchorSeg = compParms->getGnAnchorSegmentMode();
    scoreMode = compParms->getGnSegmentScoreMode();
    oopsFactor = compParms->getGnOOPSFactor();
    matchInit = compParms->getMatchGnIntial();
    initScore = compParms->getGnInitialScore();
            initialOnInitialMatchScore = compParms-
>getGnInitialOnInitialMatchScore();
    checkVariant = compParms->getUseGnVariants();
            anchorFactor = compParms->getGnAnchorFactor();
            leftDigraphBias = compParms->getUseGnLeftBias();
            nameUnknownScore = compParms->getFNUScore();
            noNameScore = compParms->getNFNScore();
```

```
            scoreTaqs = compParms->getScoreGnTAQs();
            absDelTAQFactor = compParms->getAbsDelGnTAQFactor();
            absDisTAQFactor = compParms->getAbsDisGnTAQFactor();
            delTAQFactor = compParms->getDelGnTAQFactor();
            disTAQFactor = compParms->getDisGnTAQFactor();
            compressedNameScore = compParms->getGnCompressedNameScore();
            checkCompressedName = compParms->getCheckGnCompressedName();
            variantTable = nameParms->gnVariantTable;
  }

      //    clear out the scores table
  for (qIndex = 0; qIndex < NH_MAX_SEGS_AFTER_TAQ; ++qIndex)
    for (evalIndex = 0; evalIndex < NH_MAX_SEGS_AFTER_TAQ; ++evalIndex)
      scoresTable[qIndex][evalIndex] = 0.0;

      //    now go through each possible combination of segment pairs
      //    (created by matching a query segment against an eval
segment).
      //    Store the scores in the scoresTable.
  for (qIndex = 0; qIndex < numQSegs; ++qIndex) {

    qSegLen = strlen(qSegs[qIndex].segString);

    for (evalIndex = 0; evalIndex < numEvalSegs; ++evalIndex) {

      evalSegLen = strlen(evalSegs[evalIndex].segString);

                  //    first check for either the query or eval segment
being
                  //    blank.
                  if ((qSegLen == 0) || (evalSegLen == 0))  {
                        //    We make a distinction between "unknown"
                        //    and "none".  The table below shows the
scores
                        //    we assign for the various combinations of
Known - K,
                        //    Unknown - U, and None -N.
                        //
                        //          |     K
      |     U
        |    N
                        //    ----------------------------------------
-------------------------
                        //    K     |     N/A
|     unknownScore                              |    NoneScore
                        //    ----------------------------------------
-------------------------
                        //    U     |     unknownScore|     (unknownScor
e + 1) / 2 |      (unknownScore + 1) / 2
                        //    ----------------------------------------
-------------------------
                        //    N     |     NoneScore         |     (unkno
wnScore + 1) / 2 |      (NoneScore + 1) / 2
                        //    ----------------------------------------
-------------------------


                        if (qSegs[qIndex].status ==
NH_NAME_FIELD_STATUS_KNOWN)    {
                        //    we should not need to check for both
being known
```

```
                                if (evalSegs[evalIndex].status ==
NH_NAME_FIELD_STATUS_UNKNOWN)
                                        diScore = nameUnknownScore;
                                else  //    must be
NH_NAME_FIELD_STATUS_NON_EXISTANT
                                        diScore = noNameScore;
                        }
                        else if (qSegs[qIndex].status ==
NH_NAME_FIELD_STATUS_UNKNOWN) {
                                if (evalSegs[evalIndex].status ==
NH_NAME_FIELD_STATUS_KNOWN)
                                        diScore = nameUnknownScore;
                                else if (evalSegs[evalIndex].status ==
NH_NAME_FIELD_STATUS_UNKNOWN)
                                        diScore = (nameUnknownScore + 1.0) /
2.0;
                                else  //    must be
NH_NAME_FIELD_STATUS_NON_EXISTANT,  same score as
                                                //    above, but we
repeat it in case we cange behavior later
                                        diScore = (nameUnknownScore + 1.0) /
2.0;
                        }
                        else  {     //    query must be
NH_NAME_FIELD_STATUS_NON_EXISTANT)
                                if (evalSegs[evalIndex].status ==
NH_NAME_FIELD_STATUS_KNOWN)
                                        diScore = noNameScore;
                                else if (evalSegs[evalIndex].status ==
NH_NAME_FIELD_STATUS_UNKNOWN)
                                        diScore = (nameUnknownScore + 1.0) /
2.0;
                                else  //    must be
NH_NAME_FIELD_STATUS_NON_EXISTANT,  same score as
                                                //    above, but we
repeat it in case we cange behavior later
                                        diScore = (noNameScore + 1.0) / 2.0;
                        }
                }
                else  {
                        //    check the variants if
                        //          -     we are supposed to
                        //          -     we have a list of variants to
check
                        //          -     there is a variant for this
segment of the query
                        //          Note we must check the secondary
variants if the
                        //          primary check does not find a
variant.
                        areVariants = false;
                        if (checkVariant && (querySegmentVariants !=
NULL) &&
                                        (querySegmentVariants[qIndex] !=
NULL))      {
                                //    so see if the eval name segment has
any variants in the variant table
                                evalSegVarId = variantTable-
>getVariantIdForName(evalSegs[evalIndex].segString);
                                if (evalSegVarId !=
NH_VAR_NOT_FOUND) {
```

```
                                    //    yes, it did have some
variants, so see if there is an intersection
                                    varScore =
querySegmentVariants[qIndex]-
>getVariantScoreForIdAndCulture(evalSegVarId, primaryCulture);
                                    if (varScore !=
NH_VARIANTS_NOT_RELATED)      {
                                          areVariants = true;
                                          diScore = varScore;
                                    }
                                    else  {
                                          //    variants were not
related, so check for the secondary
                                          //    variant source
                                          //    Put a check in here to
see if the primary culture
                                          //    code was
NH_CULTURE_CODE_GENERIC.  If so, we can skip this check
                                          //    since the secondary code
is always generic
                                          if (strcmp(primaryCulture,
NH_CULTURE_CODE_GENERIC))     {
                                                varScore =
querySegmentVariants[qIndex]-
>getVariantScoreForIdAndCulture(evalSegVarId, secondaryCulture);
                                                if (varScore !=
NH_VARIANTS_NOT_RELATED)      {
                                                      areVariants =
true;
                                                      diScore =
varScore;
                                                }
                                          }
                                    }
                              }

                              //    now, if we did not find variants above,
check for intials
                              // do we have an initial and are we supposed to
check them?
                              if (areVariants == false)     {
                                    if (matchInit && (qSegLen == 1 ||
evalSegLen == 1)) {
                                          //    does the first char match ?
                                          if (qSegs[qIndex].segString[0] ==
evalSegs[evalIndex].segString[0])   {
                                                //    if the second char
matches, we have an initial on inital match,
                                                //    since we know the length
of atleast one of them is 1.
                                                if (qSegs[qIndex].segString[1]
== evalSegs[evalIndex].segString[1])
                                                      diScore =
initialOnInitialMatchScore;
                                                else        //    initial
match, but one was more than a single character
                                                      diScore =
initScore;        //    so assign initScore
                                          }
                                          else
```

```
                                        diScore =
0.0;            //    no match at all, since first char was off
                    }
                    else {              //    else not initials
or we shouldn't check them
                                        //    when here, we do not
have unknowns, variants, or initials,
                                        //    so do a digraph
comparison.
                                        diScore =
NH_digraph_score(qSegs[qIndex].segString, qSegLen,

evalSegs[evalIndex].segString, evalSegLen,
                                         leftDigraphBias);
                    }
                }           //    end, if (areVariants == false)
            }           //    end, else, both segs are known
(neither name is blank)

            /*
                Here we need to handle the oops and anchor
segment parameters.
                oops specifies a factor to multiply by the score
when the segments
                are not in the same position.
                AnchorSeg, AnchorFactor specify a factor to
multiply matches that
                are in the same segment position, but are in a
segment other than
                the stated AnchorSeg.  Note that AnchorSeg does
not get applied in
                average mode, because otherwise a 2 segment name
that was
                an exact match would get less than 1.0, since
the segment that
                was not in the anchor segment would be
penalized.  Anchor Factor
                is meant more to provide a penalty when a
(relatively)
                unimportant segment is used as the sole
contributor to
                the score.

                Note that only one of the factors may be
applied, since oops only
                gets applied to segments that are out of place,
and anchorFactor
                only gets applied to matches that are in place.

                AnchorSeg is also used to determine segment
alignment. anchorSeg
                value 1 indicates segments should be lined up on
the left, while
                value 2 indicates they should be lined up on the
right.  A value
                of 0 indicates they should be lined up on the
left (this is the
                default.
            */
```

```
                switch (anchorSeg) {
                      case 0
:                                                                  //    no
anchor segment designation
                            if (qIndex != evalIndex)               //    out of
place, so apply oops
                                  diScore *= oopsFactor;
                            break;
                      case 1
:                                                                  //    first
segment is most important
                            if (qIndex !=
evalIndex)        //    out of place, so apply oops
                                  diScore *= oopsFactor;
                            else
                                  if ((qIndex != 0) && (scoreMode !=
NH_SEGMODE_AVG))        //    if not the first segment (anchor seg)
                                        diScore *=
anchorFactor;           //    apply the anchorFactor, so long as the
                            break;
                                  //    scoreMode is not
NH_SEGMODE_AVG
                      case 2 : /* If not last-to-last match... */
                            if ((qIndex == numQSegs - 1) && (evalIndex
== numEvalSegs - 1))
                                  ; // no modification, since both are
end segments
                            else  {
                                  //    see if they are in the same
position, counting back from the end
                                  if ((numQSegs - qIndex) ==
(numEvalSegs - evalIndex))
                                        if (scoreMode !=
NH_SEGMODE_AVG)         //    skip anchor factor in average seg mode
                                              diScore *=
anchorFactor;           //    apply the anchorFactor
                                        else
                                              diScore *= oopsFactor;
                            }
                            break;
                }

                //    Now we need to apply the TAQ values to the
score,
                //    but only if they wanted to, and we have a score
                //    greater than 0 (otherwise, factors have no
effect).
                if ((scoreTaqs) && (diScore > 0.0))
                      NH_apply_TAQs_to_score(&diScore, &qSegs[qIndex],
&evalSegs[evalIndex],

                            absDelTAQFactor, absDisTAQFactor,

                            delTAQFactor, disTAQFactor);

                if (numQSegs > numEvalSegs)          //    always store
smaller dimension as rows
                      scoresTable[evalIndex][qIndex] = diScore;
                else
                      scoresTable[qIndex][evalIndex] = diScore;
```

```
            hiScore = hiScore > diScore ? hiScore : diScore;

        } // for evalIndex

    } // for qIndex


    //    now figure out a composite score from all the best scores
    //    Note that for Best score, we must set the number of segments
    //    that were scored, and fill an array containing those scores
    //    these will be used later to sort hits).
    //    The exception to this is when either the query or the
    //    eval name field has just 1 segment, in which case we only
    //    score one segment, which becomes the score (in all modes).
    if ((numEvalSegs == 1) || (numQSegs == 1))      {
        if (scoreMode == NH_SEGMODE_HIGHEST)        {
            *numSegsScored = 1;             //    note that we only
scored 1 segment
            bestSegScores[0] = hiScore;         //    save the
singly scored segment
        }
        returnValue = hiScore;
    }
    else  {
        //    both have more than 1 segment
        if (numQSegs > numEvalSegs)   {         //    always call
functions with smaller dimension as rows
            if (scoreMode == NH_SEGMODE_HIGHEST)      {
                NH_best_score_for_highest_mode(numEvalSegs,
numQSegs, hiScore, bestSegScores, scoresTable);
                *numSegsScored = numEvalSegs;       //    note
that we only scored numEvalSegs segments
                returnValue = hiScore;
            }
            else
                returnValue = NH_best_score(numEvalSegs,
numQSegs, scoreMode, scoresTable);
        }
        else  {
            if (scoreMode == NH_SEGMODE_HIGHEST)      {
                NH_best_score_for_highest_mode(numQSegs,
numEvalSegs, hiScore, bestSegScores, scoresTable);
                *numSegsScored = numQSegs;          //    note
that we only scored numQSegs segments
                returnValue = hiScore;
            }
            else
                returnValue = NH_best_score(numQSegs,
numEvalSegs, scoreMode, scoresTable);
        }
    }


    //    here we need to see if we are suppoed to check compressed
names.
    //    if so, we have to call the NH_check_compressed_name()
function.
    //    If that function returns true, we pick the higher of the
    //    compressedScore (which is a parameter) and the current
returnValue.
```

```
      if (checkCompressedName &&
                          NH_check_compressed_name(origQNameField,
origEvalNameField,
                                   nameParms->getSegmentBreakChars(),
                                   nameParms->getNoiseChars()))
                     returnValue = returnValue > compressedNameScore ?
returnValue : compressedNameScore;

  return returnValue;

} /* NH_calc_score */


/* NH_check_compressed_name

      Compresses both names passed in, and sees if they are exact
matches.

      The compression is implemented by skipping characters specified in
      compressChars.
*/
bool NH_check_compressed_name(char *qSegString, char *evalSegString,
char *compressCharsPart1,
                  char  *compressCharsPart2)
{
      char  compressedQuerySeg[NH_MAX_SEG_LENGTH + 1];
      char  compressedEvalSeg[NH_MAX_SEG_LENGTH + 1];
      char  compressChars[200 + 1];
  char *p;
  char  *q;


      //    first, combine the compressCharsPart1 and compressCharsPart1
strings
      strcpy(compressChars, compressCharsPart1);
      strcat(compressChars, compressCharsPart2);

      //    compress the query segment
  for (p = qSegString, q = compressedQuerySeg; *p != EOS; p++)
    if (strchr(compressChars, *p) == NULL)
      *q++ = *p;
  *q = EOS;

      //    compress the query segment
  for (p = evalSegString, q = compressedEvalSeg; *p != EOS; p++)
    if (strchr(compressChars, *p) == NULL)
      *q++ = *p;
  *q = EOS;

      //    at this point, we are not necessarily upper cased, so ignore
case
      //    during the string copy
      return !strcasecmp(compressedQuerySeg, compressedEvalSeg);

} /* NH_check_compressed_name */
```

```
/* NH_best_score
            From a matrix of scores compute the highest possible
combination
            of scores.  During the evaluation of the matrix, a given row
or
            column must provide one and only one score.

            We use a mode to determine how we calculate a score.  The
mode
            can be either NH_SEGMODE_AVG or NH_SEGMODE_LOWEST.  Both
modes
            start out by selecting the combination of values (with no
row or
            column being used more than once) that gives the highest
sum.  Then,
            for mode = NH_SEGMODE_AVG, the final score is the average of
all
            these scores.  For NH_SEGMODE_LOWEST, it is the worst of
these scores.

            If the matrix is non-square (x <> y), our final score
calculation
            only includes N values, where N is the lesser dimension.  We
still
            use all the possible squares in the matrix to perform our
selection,
            but the final score does not consider part of the matrix.

            To perform the work, we figure out which type of matrix we
are
            dealing with (the dimensions).  We use that to select an
array that contains
            the column indexes for each valid combination of segments
(where
            valid means no column participates twice).

            Our matrix always comes either as a square, or as a fat,
short matrix.
            That is, the number of rows is always less than or equal to
the number of
            columns.  This way, we do not have to specify as many
combination arrays,
            since we only have to cover a 2 X 3 array, and not a 3 X 2.

            Also, before this function, we see if either name has just 1
            segment, in which case we use the best score.
*/
double      NH_best_score(int xDim, int yDim, NHSegScoreMode scoreMode,
                                                                  double
scores[NH_MAX_SEGS_AFTER_TAQ][NH_MAX_SEGS_AFTER_TAQ])
{
      byte  *comboIndexesPtr;             //    points to array that
holds valid column index combos
      int         numCominations;

      switch (xDim)     {
            case  2:
                  switch (yDim)     {
                        case 2:           //    2 by 2
                              comboIndexesPtr = twoByTwo;
```

```
                        numCominations = 2;
                        break;
                  case 3:           //    2 by 3
                        comboIndexesPtr = twoByThree;
                        numCominations = 6;
                        break;
                  case 4:           //    2 by 4
                        comboIndexesPtr = twoByFour;
                        numCominations = 12;
                        break;
                  case 5:           //    2 by 5
                        comboIndexesPtr = twoByFive;
                        numCominations = 20;
                        break;
                  default:          //    must be greater than 5,
so just use first five
                        comboIndexesPtr = twoByFive;
                        numCominations = 20;
                        break;
            }
            break;
      case  3:
            switch (yDim)     {
                  case 3:           //    3 by 3
                        comboIndexesPtr = threeByThree;
                        numCominations = 6;
                        break;
                  case 4:           //    3 by 4
                        comboIndexesPtr = threeByFour;
                        numCominations = 24;
                        break;
                  case 5:           //    3 by 5
                        comboIndexesPtr = threeByFive;
                        numCominations = 60;
                        break;
                  default:          //    must be greater than 5,
so just use first five
                        comboIndexesPtr = threeByFive;
                        numCominations = 60;
                        break;
            }
            break;
      case  4:
            switch (yDim)     {
                  case 4:           //    4 by 4
                        comboIndexesPtr = fourByFour;
                        numCominations = 24;
                        break;
                  case 5:           //    4 by 5
                        comboIndexesPtr = fourByFive;
                        numCominations = 120;
                        break;
                  default:          //    must be greater than 5,
so just use first five
                        comboIndexesPtr = fourByFive;
                        numCominations = 120;
                        break;
            }
            break;
      case  5:
            switch (yDim)     {
```

```
                        case 5:           //    5 by 5
                              comboIndexesPtr = fiveByFive;
                              numCominations = 120;
                              break;
                        default:          //    must be greater than 5,
so just use first five
                              comboIndexesPtr = fiveByFive;
                              numCominations = 120;
                              break;
                  }
                  break;
            default:          //    must be greater than 5, so just use
first five
                                          //    also, since xDim
is <= yDim, we do not have to
                                          //    handle 5 X 2, 5 X
3, etc
                              comboIndexesPtr = fiveByFive;
                              numCominations = 120;
                              break;
      }

      //    we always use xDim matrix cells to compute the score, since
it
      //    is the smaller of the dimensions.  We go through each
combination
      //    and evaluate the scores found in the scores array for the
      //    particular combination of indexes.
      //    Each evaluation must consider xDim values, so each pass
through the
      //    loop collects xDim values.
      //    The values from the comboIndexesPtr array are the column
indexes.
      //    numCominations is the number of times we iterate through the
loop to
      //    look at a combination of elements in the score matrix.
      //
      //    For example:
      //    if I have a 2 X 3 matrix, I need to find the best valid 2
segment
      //    combination (since 2 is xDim).  There are 6 possible
combinations,
      //    and the column values are stored as pairs in the twoByThree
array.
      //    The row values are implicitly 0 and 1 for each pair, so I
end up
      //    checking:
      //                              scores[0][twoByThree[0]] +
scores[1][twoByThree[1]];
      //                              scores[0][twoByThree[2]] +
scores[1][twoByThree[3]];
      //                              scores[0][twoByThree[4]] +
scores[1][twoByThree[5]];
      //                              scores[0][twoByThree[6]] +
scores[1][twoByThree[7]];
      //                              scores[0][twoByThree[8]] +
scores[1][twoByThree[9]];
      //                              scores[0][twoByThree[10]] +
scores[1][twoByThree[11]];
      //
      double      tempScoreTotal;
```

```
	double		tempLowScore;
	double		tempVal;
	double		highestTotal = 0.0;
	double		bestLowScore = 0.0;
	int			comboArrayIndex = 0;
	int			i, row;

	for (i = 0;  i < numCominations; i++)	{
		tempScoreTotal = 0.0;
		tempLowScore = 1.0;
		for (row = 0; row < xDim; row++)	{
			//	get a single score
			tempVal =
scores[row][comboIndexesPtr[comboArrayIndex]];
			//	now see if score is the low score for this combo
			if (tempVal < tempLowScore)
				tempLowScore = tempVal;

			//	include this cell in the total for this
combination
			tempScoreTotal += tempVal;

			//	look at next item in the combination (or the
next combination)
			comboArrayIndex++;
		}
		//	see if the low score is better than our previous low
score
		if (tempLowScore > bestLowScore)
			bestLowScore = tempLowScore;
		//	see if this score is higher than our previous highest
		if (tempScoreTotal > highestTotal)
			highestTotal = tempScoreTotal;
	}
	if (scoreMode == NH_SEGMODE_AVG)
		return highestTotal / xDim;
	else
		return bestLowScore;
}



/* NH_best_score_for_highest_mode
		This is a special version of NH_best_score.  For a complete
		description of how the combination stuff works, see the
comments
		for NH_best_score.

		We made this a separate function because:
			-	it has to return (by reference) an array of
scores.  The other
				modes only have to return a score for the name.
			-	The way we figure out which array of scores to
return is
				much more involved than NH_best_score.
			-	Since we only do this stuff in highest mode, we
did not
				want to slow down the processing of
NH_best_score by passing
				extra parameters and adding lots of "if"
statements.
```

```
This function was added so that we can figure out which
combination of segments gives us the highest scores, with
the highest score being most important, the next highest
score
being the second most important, etc.  Note that this is
different from average score, where we are looking for the
highest sum of scores.  In that case, the higest score is no
more important that the lowest score.  In fact, the
combination
chosen in average mode might not even include the single
highest
segment score.

To achieve our goal, we evaluate each possible combination
of
index pairings.  Each combination gives us an array of N
scores,
where n is the smaller dimension in the matrix.

We sort each combination so that the highest score appears
first
in the array, and so on.  If this is the first combination
we
have evaluated, it becomes the one to beat, so we fill up
the
array of scores we were passed by reference with this array
of
scores.  We then go through the rest of the combinations
looking
for an array that beats the current one to beat.  To beat
it, as
we walk through the array, we compare the scores from each
array.
If they are equal, we move on to the next one.  Otherwise,
the
higher score wins.

To help speed things up, we get passed in the high score,
which
is the high score of the entire matrix (note this high score
could
appear more than once).  We use this high score to quickly
discount
combinations as not being possible contenders.  If, after
sorting
a contender array, the first item is not the high score we
were
passed, this combination could not possibly be the one, so
why
bother copying all the array elements?

Note that we check before entering this function to make
sure
both dimensions are bigger than 1.  And we make sure that
xdim is the smaller of the dimensions (or they are equal).
*/
void  NH_best_score_for_highest_mode(int xDim, int yDim, double
highestScore,
                                                    double
*bestSegScores,
```

```
                                                                  double
scores[NH_MAX_SEGS_AFTER_TAQ][NH_MAX_SEGS_AFTER_TAQ])
{
      byte  *comboIndexesPtr;             //    points to array that
holds valid column index combos
      int         numCominations;

      switch (xDim)     {
            case  2:
                  switch (yDim)     {
                        case 2:           //    2 by 2
                              comboIndexesPtr = twoByTwo;
                              numCominations = 2;
                              break;
                        case 3:           //    2 by 3
                              comboIndexesPtr = twoByThree;
                              numCominations = 6;
                              break;
                        case 4:           //    2 by 4
                              comboIndexesPtr = twoByFour;
                              numCominations = 12;
                              break;
                        case 5:           //    2 by 5
                              comboIndexesPtr = twoByFive;
                              numCominations = 20;
                              break;
                        default:          //    must be greater than 5,
so just use first five
                              comboIndexesPtr = twoByFive;
                              numCominations = 20;
                              break;
                  }
                  break;
            case  3:
                  switch (yDim)     {
                        case 3:           //    3 by 3
                              comboIndexesPtr = threeByThree;
                              numCominations = 6;
                              break;
                        case 4:           //    3 by 4
                              comboIndexesPtr = threeByFour;
                              numCominations = 24;
                              break;
                        case 5:           //    3 by 5
                              comboIndexesPtr = threeByFive;
                              numCominations = 60;
                              break;
                        default:          //    must be greater than 5,
so just use first five
                              comboIndexesPtr = threeByFive;
                              numCominations = 60;
                              break;
                  }
                  break;
            case  4:
                  switch (yDim)     {
                        case 4:           //    4 by 4
                              comboIndexesPtr = fourByFour;
                              numCominations = 24;
                              break;
                        case 5:           //    4 by 5
```

```
                        comboIndexesPtr = fourByFive;
                        numCominations = 120;
                        break;
                  default:          //    must be greater than 5,
so just use first five
                        comboIndexesPtr = fourByFive;
                        numCominations = 120;
                        break;
            }
            break;
      case  5:
            switch (yDim)     {
                  case 5:           //    5 by 5
                        comboIndexesPtr = fiveByFive;
                        numCominations = 120;
                        break;
                  default:          //    must be greater than 5,
so just use first five
                        comboIndexesPtr = fiveByFive;
                        numCominations = 120;
                        break;
            }
            break;
      default:          //    must be greater than 5, so just use
first five
                                    //    also, since xDim
is <= yDim, we do not have to
                                    //    handle 5 X 2, 5 X
3, etc
                        comboIndexesPtr = fiveByFive;
                        numCominations = 120;
                        break;
   }

   //    we always use xDim matrix cells to compute the score, since
it
   //    is the smaller of the dimensions.  We go through each
combination
   //    and evaluate the scores found in the scores array for the
   //    particular combination of indexes.
   //    Each evaluation must consider xDim values, so each pass
through the
   //    loop collects xDim values.
   //    The values from the comboIndexesPtr array are the column
indexes.
   //    numCominations is the number of times we iterate through the
loop to
   //    look at a combination of elements in the score matrix.
   //
   //    For example:
   //    if I have a 2 X 3 matrix, I need to find the best valid 2
segment
   //    combination (since 2 is xDim).  There are 6 possible
combinations,
   //    and the column values are stored as pairs in the twoByThree
array.
   //    The row values are implicitly 0 and 1 for each pair, so I
end up
   //    checking:
   //                        scores[0][twoByThree[0]] +
scores[1][twoByThree[1]];
```

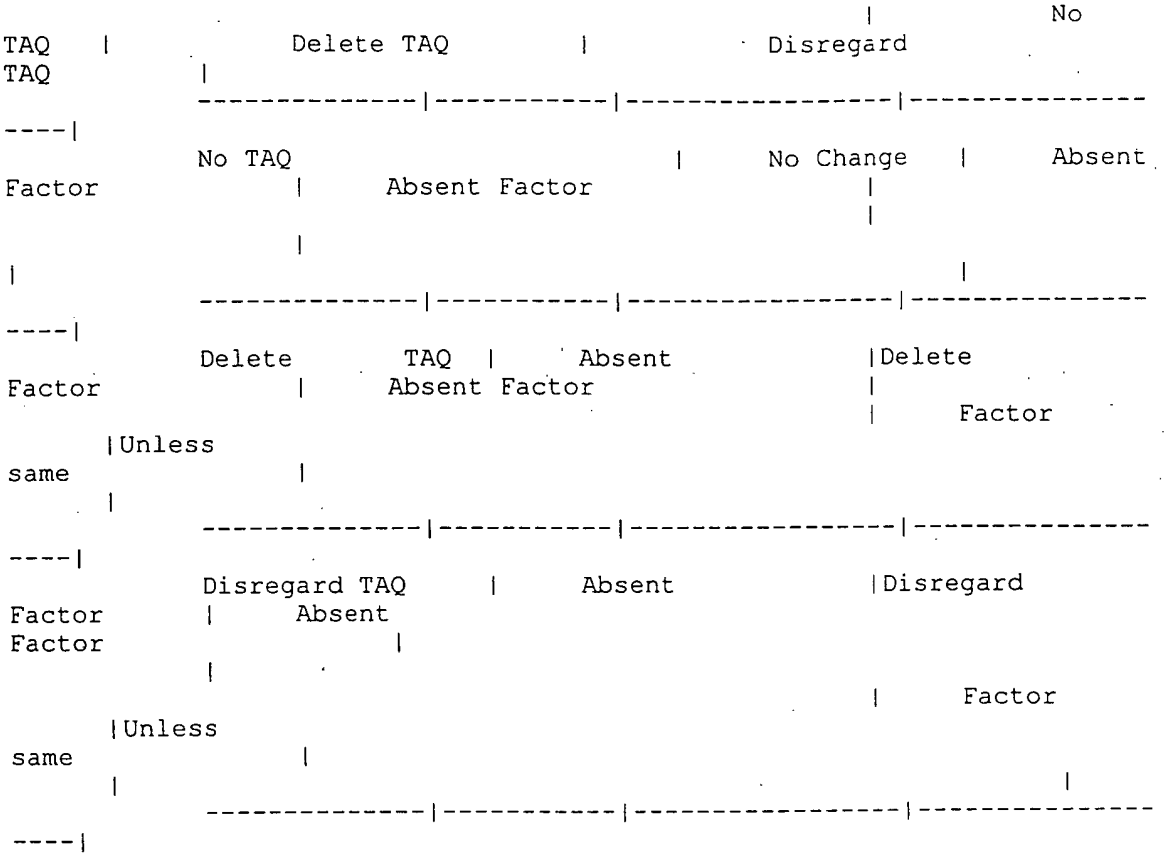
```
      //                                scores[0][twoByThree[2]] +
scores[1][twoByThree[3]];
      //                                scores[0][twoByThree[4]] +
scores[1][twoByThree[5]];
      //                                scores[0][twoByThree[6]] +
scores[1][twoByThree[7]];
      //                                scores[0][twoByThree[8]] +
scores[1][twoByThree[9]];
      //                                scores[0][twoByThree[10]] +
scores[1][twoByThree[11]];
      //
      double      tempSegScores[NH_MAX_SEGS_AFTER_TAQ];
      int               comboArrayIndex = 0;
      int               i, row;
      bool        includesHighestScore;
      double      swapVal;
      int               tempIndex;
      double      compVal;
      int               numChanges;
      double      tempVal;


      //    init the temp seg scores array to zeros, so that the first
      //    comparison will fail.
      for (tempIndex = 0; tempIndex < xDim; tempIndex++)    {
            bestSegScores[tempIndex] = 0;
      }

      for (i = 0;  i < numCominations; i++)     {
            includesHighestScore = false; //    assume this combo does
not

                              //    include the best score
            for (row = 0; row < xDim; row++)    {
                  //    get a single score
                  tempVal =
scores[row][comboIndexesPtr[comboArrayIndex]];

                  //    now see if score is the low score for this combo
                  if (tempVal == highestScore)
                        includesHighestScore = true;

                  //    save this value as part of our temp array of
scores
                  //    that we will sort below
                  tempSegScores[row] = tempVal;

                  //    look at next item in the combination (or the
next combination)
                  comboArrayIndex++;
            }
            //    see if this combo includes the best score.   If so,
sort it
            //    and then compare it to the current numbers in
bestSegScores.
            if (includesHighestScore == true)   {
                  //    sort the numbers in bestSegScores
                  while (1)   {
                        numChanges = 0;
                        for (tempIndex = 1; tempIndex < xDim;
tempIndex++)      {
```

```
                                    if (tempSegScores[tempIndex - 1] <
tempSegScores[tempIndex])           {
                                          swapVal = tempSegScores[tempIndex -
1];
                                          tempSegScores[tempIndex - 1] =
tempSegScores[tempIndex];
                                          tempSegScores[tempIndex] = swapVal;
                                          numChanges++;
                                    }
                              }
                              if (numChanges == 0)
                                    break;
                        }

                        //    now compare these temp scores to the current
best scores
                        for (tempIndex = 0; tempIndex < xDim;
tempIndex++)       {
                              compVal = tempSegScores[tempIndex] -
bestSegScores[tempIndex];
                              if (compVal > 0)  {
                                    //    temp scores are better, so replace
the best scores with them
                                    for (tempIndex = 0; tempIndex < xDim;
tempIndex++)       {
                                          bestSegScores[tempIndex] =
tempSegScores[tempIndex];
                                    }
                                    break;
                              }
                              else
                                    if (compVal < 0)  {
                                          //    current scores are better, so
break out
                                          break;
                                    }
                                    //    otherwise, just continue the loop.
                        }
                  }
            }
}



/* digraph_score
     This is the core of the name-check algorithm.
     A value from 0.0 to 1.0 is calculated based on the number of
     digraphs which match between the two given strings.
     A bias can be used so that digraphs on the right end of the
     strings count less than those on the left.

      Notes:
            The routine ensures that a digraph can only participate in a
            match once.

            Each match results in two points being added to the total.
The
            final score is the total number of points divided by the
number
            of digraphs that could have matched.
```

```
            The bias works by discounting the score we award for a
digraph
            match.  As we move into the segment, we subtract 0.1 from
the
            match score.

            The weight table is used to adjust the divisor (which is
normally
            the total number of digraphs that could have matched).  In
the case
            of bias, we need to decrease that number.  Otherwise, an
exact match
            would not return a 1.0, since we would only be deducting
from the
            score (the numerator), and not the divisor.  The weight
table factors
            correspond to the score that would be assigned to an exact
match for
            each possible length.  In other words, we start at 1, then
add .9, then
            add .8, etc.  (the same pattern we use to deduct from the
match score)
*/
double      NH_digraph_score(char *qSeg, int qSegLen,

char *evalSeg, int evalSegLen,
                        bool useLeftDigraphBias)
{
      char tempDigraphStr[2 + 1]; // storage for a digraph string


      //    terminate the temp digraph string once
      tempDigraphStr[2] = EOS;

      //    These are the weights a name has when using a biased
      //    (left-to-right) calculation.  They end up being used as the
denominator
      //    for the final score calculation
      static const double NH_dig_bias_weights[NH_MAX_SEG_LENGTH + 2]
            = { 1.0, 1.0, 1.9, 2.7, 3.4, 4.0, 4.5, 4.9, 5.2, 5.4, 5.5,
5.6, 5.7,
                                    5.8, 5.9, 6.0, 6.1, 6.2, 6.3, 6.4,
6.5, 6.6, 6.7, 6.8, 6.9, 7.0,
                                          7.1, 7.2, 7.3, 7.4, 7.5, 7.6};


      //    an array of 'Y' or 'N' values, one for each possible digraph
      //    position in the eval segment.  Each starts out at 'N' and
gets
      //    to 'Y' when (and if) it gets used.
      //    Note that we must add 1 because we normally pad the name
with
      //    spaces.
      char alreadyMatched[NH_MAX_SEG_LENGTH + 1]; // max digraphs =
NAME_SIZE + 1

      // Forget all previous matches.
      memset(alreadyMatched, 'N', sizeof alreadyMatched);

      // Now count the number of elements involved in matching.
      double      qBiasFactor = 0.9;                  //    0.9 because
```

```
of leading digraph check
      double      evalBiasFactor = 0.9;          //    see note below
      double      matchPoints;
      char        *evalSegString;


      //    start out by checking the first character, which is a
special
      //    case.  It forms an implied digraph of " X" (space, followed
by
      //    the character.  Thus, if both the query and eval have the
same
      //    first character, we give them 2 match points.
      //    Also, since we really start our loop with the second
digraph,
      //    we set the bias factors to 0.9 rather than 1.0
      if (qSeg[0] == evalSeg[0])    {
            matchPoints = 2.0;
      }
      else
            matchPoints = 0.0;

      for (int queryIndex = 0; queryIndex < qSegLen - 1; ++queryIndex) {
            /* see if this digraph occurs in database name */
            tempDigraphStr[0] = qSeg[queryIndex];
            tempDigraphStr[1] = qSeg[queryIndex + 1];
            evalSegString = evalSeg;
            if (useLeftDigraphBias) {
                  //    bring down the query bias by 0.1 each time,
until we get to 0.1
                  if ((queryIndex > 0) && (queryIndex <  10))
                        qBiasFactor -= 0.1;
            }
            do {
                  evalSegString = strstr(evalSegString, tempDigraphStr);
                  if (evalSegString != NULL) {
                        int evalMatchOffset = evalSegString - evalSeg;

                        if (alreadyMatched[evalMatchOffset] == 'N') {
                              alreadyMatched[evalMatchOffset] = 'Y';
                              if (useLeftDigraphBias) { /* decrement
eval match-bias, minimum 0.10 */
                                    evalBiasFactor = 1.0 - 0.1 *
(evalMatchOffset + 1);
                                    if (evalBiasFactor < 0.1)
                                          evalBiasFactor = 0.1;
                                    matchPoints += qBiasFactor +
evalBiasFactor;
                              }
                              else
                                    matchPoints += 2.0;
                              break;
                              }
                        else
                              evalSegString++;
                  }
            } while (evalSegString != NULL);
      }

      //    now do a check for the "hidden" digraph at the end of the
segment
```

```
      //    to account for the non-existant trailing space
      if (qSeg[qSegLen - 1] == evalSeg[evalSegLen - 1])      {
            if (useLeftDigraphBias) {
                  evalBiasFactor = 1.0 - 0.1 * evalSegLen;
                  if (evalBiasFactor < 0.1)
                        evalBiasFactor = 0.1;
                  //    don't forget to bring down the query bias by 0.1
also,
                  //    unless we are at 0.1
                  if ((queryIndex > 0) && (queryIndex <  10))
                        qBiasFactor -= 0.1;
                  matchPoints += qBiasFactor + evalBiasFactor;
            }
            else
                  matchPoints += 2.0;
      }


      // The return value is the number of elements involved in matching
      // compared to the total number of elements.
      return useLeftDigraphBias
                              ? matchPoints /
(NH_dig_bias_weights[qSegLen + 1] + NH_dig_bias_weights[evalSegLen + 1])
                              : matchPoints / (qSegLen + evalSegLen +
2);
} /* NH_digraph_score */



/*
      This function adjusts the diScore (which already has some value)
based
      on the TAQ values that are attached to the two segments passed in.

      In the NameHunter system, TAQs are broken up into two types
(disregard and
      delete).  In general, disregard TAQs (e.g. "Jr.") contain more
      meaningful information than delete TAQs (e.g. "Mr."), and thus
      disregard TAQs are considered more important when
evaluating/comparing
      TAQs between segments.

      There are three factors involved in modifying the score.  These
are

            -     delete factor
            -     disregard factor
            -     absent factor

      When applied, a factor is multiplied by the existing score.
However,
      deciding which factor (if any) to apply is somewhat complex,
especially
      when one or both of the segments have multiple TAQ values.  For
this
      reason, we describe the multi-TAQ situation separately.

      For situations where both segments have either 0 or 1 TAQ values,
we
      use the following matrix to choose a factor to apply:
```



For the multiple case, we use the algorithm below. A general word about the alg - we are treating disregard as more important than delete, so we start out by checking for disregards. All it takes is for one disregard value in each of the segments to match to avoid applying the disregard factor. The same goes for deletes. If we have any dis values in one segment, but none in the other, we apply the absent factor.

Assuming segments S1 and S2:

- Look for dis segments in S1
- if found
  - if same segment found in S2
    - go on to delete processing
  - else
    - if no dis segments in S2
      - apply absent value
    - else, continue looking for dis segments in S1 that match S2
      if we get to end of S1 segments and still have not found a
      matching dis in S2, apply dis factor.
- else (no dis found in S1)
  - look for dis in S2
    - if found
      - apply absent

```
                  -     else
                        -     go on to delete processing

      Delete processing:

      -     look for deletes in S1
            -     if found
                  -     if same seg found in S2
                        -     do nothing
                  -     else
                        -     if no deletes in S2
                              -     apply absent
                        -     else
                              -     continue to look for deletes in S1.
If we get to end if
                                    S1 segments and do not find any
deletes that match a
                                    delete in S2, apply delete factor

            -     else  (not deletes found in S1)
                  -     look for deletes in S2
                        -     if delete found
                              -     apply absent
                        -     else
                              -     do nothing.
*/
void  NH_apply_TAQs_to_score(double *diScore, Segment *qSeg, Segment
*evalSeg,
                        double absDelTAQFactor,

                        double absDisTAQFactor,

                        double delTAQFactor,

                        double disTAQFactor)
{
      int               numQTAQs = qSeg->numTAQs;
      int               numEvalTAQs = evalSeg->numTAQs;
      double      applyFactor = 1.0;


      //    handle the simple case first
      if ((numQTAQs <= 1) && (numEvalTAQs <= 1))      {
            switch      (numQTAQs)  {
                  case  0:
                        if (numEvalTAQs == 1)   {
                              if (evalSeg->taqList[0].taqAction ==
NH_TAQ_ACTION_DELETE)
                                    applyFactor = absDelTAQFactor;
                              else
                                    applyFactor = absDisTAQFactor;
                        }
                        break;
                  case  1:
                        if (numEvalTAQs == 1)   {
                              //    both segs have 1 TAQ value, so
                              //    figure out the type of TAQs involved
                              if (qSeg->taqList[0].taqAction ==
NH_TAQ_ACTION_DELETE)   {
                                    if (evalSeg->taqList[0].taqAction ==
```

```
NH_TAQ_ACTION_DELETE)   {
                                        //    same action, so see if
string are the same
                                        if (strcmp(qSeg-
>taqList[0].segString,
      evalSeg->taqList[0].segString))
                                              applyFactor =
delTAQFactor;                   //    they were different, so apply delete
factor
                                        }
                                        else        //    not the same
action, so do the absent
                                              applyFactor = absDisTAQFactor;
                                  }
                                  else  {           //    not
NH_TAQ_ACTION_DELETE, so must be
                                                          //    disreg
ard
                                        if (evalSeg->taqList[0].taqAction ==
NH_TAQ_ACTION_DISREGARD)      {
                                              //    same action, so see if
string are the same
                                              if (strcmp(qSeg-
>taqList[0].segString,
      evalSeg->taqList[0].segString))
                                                    applyFactor =
disTAQFactor;                   //    they were different, so apply dis
factor
                                              }
                                              else        //    not the same
action, so do the absent dis
                                                    applyFactor =
absDisTAQFactor;  //    since dis takes precidence of del
                                              }
                                  }
                                  else  {     //    query had 1 TAQ, but eval had
none
                                        if (qSeg->taqList[0].taqAction ==
NH_TAQ_ACTION_DELETE)
                                              applyFactor = absDelTAQFactor;
                                        else
                                              applyFactor = absDisTAQFactor;
                                  }
                                  break;
            }
      }
      else  {
            //    one (or both) of the segments has more than 1 TAQ
value

            //    First see if either has no TAQ segments.  In this
case,
            //    we can apply the absent factor and skip the ugly
processing
            //    below
            if (numQTAQs == 0)      {
                  //    assume the abs del factor, but look for a DIS in
the
                  //    eval.  If we find one, set the applyFactor to
```

```
the abs dis
                //    since that should take precidence
                applyFactor = absDelTAQFactor;
                for   (int evalIndex = 0; evalIndex < numEvalTAQs;
evalIndex++)      {
                      if (evalSeg->taqList[evalIndex].taqAction ==
NH_TAQ_ACTION_DISREGARD)      {
                            applyFactor = absDisTAQFactor;
                            break;
                      }
                }
          }
          else if (numEvalTAQs == 0)    {
                //    assume the abs del factor, but look for a DIS in
the
                //    query.  If we find one, set the applyFactor to
the abs dis
                //    since that should take precidence
                applyFactor = absDelTAQFactor;
                for   (int qIndex = 0; qIndex < numQTAQs;
qIndex++)   {
                      if (qSeg->taqList[qIndex].taqAction ==
NH_TAQ_ACTION_DISREGARD)      {
                            applyFactor = absDisTAQFactor;
                            break;
                      }
                }
          }
          else  {
                //    one segment has 2 or more TAQs, and the other
has one or more

                bool  satisfiedDis = true;    //    we assume we have
satified the

                            //    dis processing until we find

                            //    a dis value, since if neither

                            //    seg has a dis value, we do not

                            //    apply the dis value
                bool  satisfiedDel = true;    //    we assume we have
satified the

                            //    del processing until we find

                            //    a del value, since if neither

                            //    seg has a del value, we do not

                            //    apply the del value
                bool  satisfiedAbs = true;    //    we assume we have
satified the

                            //    abs processing.
                bool  foundMatchingDis = false;
                bool  foundMatchingDel = false;


                int   i, j;
```

```
                //    go through the query segment, looking for dis
segments
                for   (i = 0; i < numQTAQs; i++)     {
                      if (qSeg->taqList[i].taqAction ==
NH_TAQ_ACTION_DISREGARD)      {
                      //    since we found a dis, we must find a
dis in the eval seg.
                      satisfiedDis = false;
                      satisfiedAbs = false;
                      //    look for disregards in the eval seg.
                      for   (j = 0; j < numEvalTAQs; j++).{
                            if (evalSeg->taqList[j].taqAction ==
NH_TAQ_ACTION_DISREGARD)      {
                                  //    found a dis, so we are
not dealing with an absent
                                  //    situation - see if the
segs are the same.
                                  satisfiedAbs = true;
                                  if (!strcmp(qSeg-
>taqList[i].segString,
      evalSeg->taqList[j].segString))     {
                                        foundMatchingDis = true;
                                        satisfiedDis = true;
                                        break;
                                  }
                            }
                      }

                      //    if we get here, and the abs has not
been satified, we
                      //    apply the abs factor, since we did
not find any dis in the
                      //    eval, but did find one in the query.
                      if (satisfiedAbs == false)     {
                            applyFactor = absDisTAQFactor;
                            //    mark the DIS as satisfied so
that we do not
                            //    re-assign the factor below
when seeing if DEL was satisfied.
                            satisfiedDis = true;
                            break;
                      }
                      else  {
                            //    check to see if we satisfied
the dis.  If we did, we can
                            //    go check out the delete stuff.
                            if (satisfiedDis == true)
                                  break;
                      }
                }
          }               //    end for query TAQ

          //    once here, we made it to the end of the query
TAQs while looking
          //    for disregards.  This means either:
          //          -     we found no disregards in the query
- so go on
          //                      and see if there are any
```

```
disregards in the Eval
                //          -     we found disregards in Q, but none
in Eval - we
                //                apply the absent factor, and
we're done
                //          -     we found dis in Q, but no matching
ones in Eval - we
                //                apply the disregard factor,
and we're done
                //          -     we found a matching dis in Q and
Eval  -     so do deletes.
                //                we can skip the check for
disregards in Eval, since
                //                we already know there is a
match.

                //    make sure we should continue
                if (satisfiedAbs && satisfiedDis)   {
                      //
                      if (foundMatchingDis == false)      {
                            //    We are in this section if the Q had
no Dis Values.
                            //    see if there are dis values in Eval.
                            for   (j = 0; j < numEvalTAQs; j++) {
                                  if (evalSeg->taqList[j].taqAction ==
NH_TAQ_ACTION_DISREGARD)      {
                                        applyFactor = absDisTAQFactor;
                                        satisfiedAbs = false;
                                        break;
                                  }
                            }
                      }

                      //    see if we should still continue after
checking for reverse absent
                      if (satisfiedAbs) {
                            //    when here, we got passed checking
for the dis, so we need to check for
                            //    deletes.

                            //    go through the query segment,
looking for del segments
                            for   (i = 0; i < numQTAQs; i++)    {
                                  if (qSeg->taqList[i].taqAction ==
NH_TAQ_ACTION_DELETE)   {
                                        //    since we found a del, we
must find a del in the eval seg.
                                        satisfiedDel = false;
                                        satisfiedAbs = false;
                                        //    look for deletes in the
eval seg.
                                        for   (j = 0; j < numEvalTAQs;
j++)  {
                                              if (evalSeg-
>taqList[j].taqAction == NH_TAQ_ACTION_DELETE)  {
                                                    //    found a del,
so we are not dealing with an absent
                                                    //    situation -
see if the segs are the same.
                                                    satisfiedAbs =
true;
```

```
                                                        if (!strcmp(qSeg-
>taqList[i].segString,
                  evalSeg->taqList[j].segString),       {
                                                              foundMatchin
gDel = true;
                                                              satisfiedDel
= true;
                                                              break;
                                                        }
                                                  }
                                                  //    if we get here, and the
abs has not been satified, we
                                                  //    apply the abs factor,
since we did not find any del in the
                                                  //    eval, but did find one
in the query.
                                                  if (satisfiedAbs ==
false)      {
                                                        applyFactor =
absDelTAQFactor;
                                                        //    mark the DEL as
satisfied so that we do not
                                                        //    re-assign the
factor below when seeing if DEL was satisfied.
                                                        satisfiedDel =
true;
                                                        break;
                                                  }
                                                  else  {
                                                        //    check to see if we
satisfied the del.  If we did, were done
                                                        if (satisfiedDel ==
true)
                                                              break;
                                                  }
                                            }
                                      }           //    end for query TAQ

                                      //    make sure we should continue
                                      if (satisfiedAbs && satisfiedDel)   {
                                            if (foundMatchingDel ==
false)      {
                                                  //    We are in this section
if the Q had no Del Values.
                                                  //    see if there are del
values in Eval.
                                                  for   (j = 0; j < numEvalTAQs;
j++)  {
                                                        if (evalSeg-
>taqList[j].taqAction == NH_TAQ_ACTION_DELETE)  {
                                                              applyFactor =
absDelTAQFactor;
                                                              satisfiedAbs =
false;
                                                              break;
                                                        }
                                                  }
                                            }
```

```
                        }

                    }
                }

                //    decide the factor based on the condition that
was not satisfied
                //    except for abs, in which case we already set the
applyFactor
                //    above
                if (satisfiedDel == false)
                    applyFactor = delTAQFactor;
                else  if (satisfiedDis == false)
                    applyFactor = disTAQFactor;

            }
        }

        //    apply the factor we decided on
        *diScore *= applyFactor;
}
```

```
// DigraphBitmapArray.hpp : header file
//
//    Class that holds the bit patterns for each possible
//    digraph (AA - ZZ).  We also need to account for spaces.
//
//    Each bit pattern turns on just 1 bit.  We basically turn
//    on one bit, and shift it through the value until it reaches
//    the other end, at which time we start back at the beginning
//    again.
//
//    Any other character are treated as spaces in our scheme,
//    so we do not need to worry about them.
//
//    The class supports either a 32 bit value, or a 64 bit value.
////////////////////////////////////////////////////////////////////////////
/////

#ifndef DIGRAPHBITMAPARRAY_HPP
#define DIGRAPHBITMAPARRAY_HPP


//    How many indexes do we need in our two dimensional array?
//    27 (26 letters plus a space)
#define           BITMAP_ARRAY_INDEX_SIZE       27


typedef           struct      {
      unsigned    int   hiBytes;
      unsigned    int   lowBytes;
}           bit_64_t;


class NHDigraphBitmapArray
{
// Construction
public:
      NHDigraphBitmapArray(); // standard constructor

      ~NHDigraphBitmapArray();

      unsigned int      get32BitKeyForToken(char *token);

      void                        get64BitKeyForToken(char *token,
bit_64_t *key);

      unsigned char     getNumBitsForByte(unsigned char byteVal) {return
bitTable[byteVal];}

// Implementation
protected:

      void  buildBitTable();

      //    the array that holds the bit map paterns for each possible
      //    digraph.  Each item in the array is an integer that has
      //    one of its 32 bits turned on.
      unsigned
int         bitMapArray32[BITMAP_ARRAY_INDEX_SIZE][BITMAP_ARRAY_INDEX_SI
ZE];

      //    the array that holds the bit map paterns for each possible
```

```
      //    digraph.  Each item in the array is an integer that has
      //    one of its 64 bits turned on.
      bit_64_t                        bitMapArray64[BITMAP_ARRAY_INDEX_SIZ
E][BITMAP_ARRAY_INDEX_SIZE];

      unsigned char           bitTable[256];

};


#endif
```

```
// NHDigraphBitmapArray.cpp : implementation file
//
//          3/20/98     EFB         Changed names to NH from SN

#include "NHDigraphBitmapArray.hpp"

#include    <stdio.h>

#ifdef _DEBUG
#define new DEBUG_NEW
#undef THIS_FILE
static char THIS_FILE[] = __FILE__;
#endif


typedef     unsigned char byte;


/////////////////////////////////////////////////////////////////////////////
/////
//    Constructor.
//    Fills in the values in both of the bitMapArrays (32 bit and
//    64 bits).
NHDigraphBitmapArray::NHDigraphBitmapArray()
{
      unsigned int      bitmapValue32 = 1;
      unsigned int      bitmapValue64High = 0;
      unsigned int      bitmapValue64Low = 1;

      for   (int i = 0; i < BITMAP_ARRAY_INDEX_SIZE; i++)   {
            for   (int j = 0; j < BITMAP_ARRAY_INDEX_SIZE; j++)   {

                  //    assign the 32 bit value
                  bitMapArray32[i][j] = bitmapValue32;

                  //    assign the 64 bit value
                  bitMapArray64[i][j].hiBytes = bitmapValue64High;
                  bitMapArray64[i][j].lowBytes = bitmapValue64Low;

                  //    now shift the values
                  bitmapValue32 <<= 1;
                  if (bitmapValue32 == 0)
                        bitmapValue32 = 1;

                  if (bitmapValue64Low == 0)    {
                        bitmapValue64High <<= 1;
                        if (bitmapValue64High == 0)   {
                              bitmapValue64Low = 1;
                        }
                  }
                  else  {
                        bitmapValue64Low <<= 1;
                        if (bitmapValue64Low == 0)    {
                              bitmapValue64High = 1;
                        }
                  }
            }
      }

      buildBitTable();
}
```

```
NHDigraphBitmapArray::~NHDigraphBitmapArray()
{
}


void  NHDigraphBitmapArray::get64BitKeyForToken(char *token, bit_64_t
*key)
{
      char                                    *ch1;
      char                                    *ch2;
      int                                           index1;
      int                                           index2;
      char                                    spacedToken[200];

      //    zero out the key we are going to return
      key->hiBytes = 0;
      key->lowBytes = 0;

      sprintf(spacedToken, " %s ", token);

      ch1 = spacedToken;
      if (*ch1 != '\0') {
            ch2 = ch1 + 1;
            while (*ch2 != '\0')    {
                  if (*ch1 == ' ')
                        index1 = 26;
                  else
                        index1 = *ch1 - 'A';
                  if (*ch2 == ' ')
                        index2 = 26;
                  else
                        index2 = *ch1 - 'A';
                  if ((index1 >= 0) && (index1 <
BITMAP_ARRAY_INDEX_SIZE)
                              &&  (index2 >= 0) && (index2 <
BITMAP_ARRAY_INDEX_SIZE))     {
                        key->hiBytes |=
bitMapArray64[index1][index2].hiBytes;
                        key->lowBytes |=
bitMapArray64[index1][index2].lowBytes;
                  }
                  ch1 = ch2;
                  ch2++;
            }
      }

}


unsigned int      NHDigraphBitmapArray::get32BitKeyForToken(char *token)
{
      unsigned int            retVal = 0;
      char                                    *ch1;
      char                                    *ch2;
      int                                           index1;
      int                                           index2;
      char                                    spacedToken[200];
```

```
	sprintf(spacedToken, " %s ", token);

	ch1 = spacedToken;
	if (*ch1 != '\0') {
		ch2 = ch1 + 1;
		while (*ch2 != '\0')	{
			if (*ch1 == ' ')
				index1 = 26;
			else
				index1 = *ch1 - 'A';
			if (*ch2 == ' ')
				index2 = 26;
			else
				index2 = *ch1 - 'A';
			if ((index1 >= 0) && (index1 <
BITMAP_ARRAY_INDEX_SIZE)
					&&  (index2 >= 0) && (index2 <
BITMAP_ARRAY_INDEX_SIZE))
				retVal |= bitMapArray32[index1][index2];
			ch1 = ch2;
			ch2++;
		}
	}

	return retVal;
}


//	build a table that says how many bits a byte value
//	has turned off.
void  NHDigraphBitmapArray::buildBitTable()
{
	byte  tempByte;
	int		i, j;
	byte  bitsTurnedOff;

	for (i = 0; i < 256; i++)	{
		tempByte = i;
		bitsTurnedOff = 0;
		for (j = 0; j < 8; j++) {
			if (tempByte & 1)			//	use this
when array says how many 1's
			//	if ((tempByte & 1) == 0)		//	use
this when array says how many 0's
				bitsTurnedOff++;
			tempByte >>= 1;
		}
		bitTable[i] = bitsTurnedOff;
	}
}
```

```
//    File:  NHCompParms.cpp
//
//    Description:
//
//          Implementation to the NHCompParms class.
//
//
//    History:
//
//          5/8/97      EFB         Created
//          3/3/98      EFB         Changed name of class, and move PP
parms to
//                                                    the new
NHNameParms class.
//          3/20/98     EFB         Changed names to NH from SN
//



#include <string.h>
#include <stdio.h>
#include <stdlib.h>


#include    "NHCompParms.hpp"
#include    "NHVariantTable.hpp"
#include    "NHTAQTable.hpp"
#include    "NH_variant_taq_globals.h"


NHCompParms::NHCompParms(NHParmsType parmsType)
{
      status = NH_SUCCESS;


      switch (parmsType)      {

            case  NH_PARMS_GENERIC:                    //    default
                  scoreThresh = 0.6;
                  useGnLeftBias = false;
                  useSnLeftBias = false;
                  matchGnIntial = true;
                  matchSnIntial = false;
                  gnInitialScore = 0.85;
                  snInitialScore = 0.0;
                  gnInitialOnInitialMatchScore = 1.0;
                  snInitialOnInitialMatchScore = 0.0;
                  useGnVariants = true;
                  useSnVariants = true;
                  fnuScore = 0.60;
                  nfnScore = 0.65;
                  lnuScore = 0.6;
                  nlnScore = 0.65;
                  gnAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
                  snAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
                  gnAnchorFactor = 0.0;
                  snAnchorFactor = 0.0;
                  gnOOPSFactor = 0.6;
                  snOOPSFactor = 0.6;
                  disGnTAQFactor = 0.7;
                  absDelGnTAQFactor = 0.9;
```

```
        absDisGnTAQFactor = 0.8;
        delGnTAQFactor = 0.85;
        disSnTAQFactor = 0.7;
        absDelSnTAQFactor = 0.9;
        absDisSnTAQFactor = 0.8;
        delSnTAQFactor = 0.85;
        checkGnCompressedName = false;
        checkSnCompressedName = false;
        gnCompressedNameScore = 0.0;
        snCompressedNameScore = 0.0;
        scoreGnTaqs = true;
        scoreSnTaqs = true;
        gnSegmentScoreMode = NH_SEGMODE_AVG;
        snSegmentScoreMode = NH_SEGMODE_AVG;
        gnScoreThresh = 0.5;
        snScoreThresh = 0.5;
        gnWeight = 0.8;
        snWeight = 1.0;
        break;

    case  NH_PARMS_ANGLO:
        scoreThresh = 0.6;
        useGnLeftBias = false;
        useSnLeftBias = false;
        matchGnIntial = true;
        matchSnIntial = false;
        gnInitialScore = 0.85;
        snInitialScore = 0.0;
        gnInitialOnInitialMatchScore = 1.0;
        snInitialOnInitialMatchScore = 0.0;
        useGnVariants = true;
        useSnVariants = true;
        fnuScore = 0.60;
        nfnScore = 0.65;
        lnuScore = 0.6;
        nlnScore = 0.65;
        gnAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
        snAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
        gnAnchorFactor = 0.0;
        snAnchorFactor = 0.0;
        gnOOPSFactor = 0.6;
        snOOPSFactor = 0.6;
        disGnTAQFactor = 0.7;
        absDelGnTAQFactor = 0.9;
        absDisGnTAQFactor = 0.8;
        delGnTAQFactor = 0.85;
        disSnTAQFactor = 0.7;
        absDelSnTAQFactor = 0.9;
        absDisSnTAQFactor = 0.8;
        delSnTAQFactor = 0.85;
        checkGnCompressedName = false;
        checkSnCompressedName = false;
        gnCompressedNameScore = 0.0;
        snCompressedNameScore = 0.0;
        scoreGnTaqs = true;
        scoreSnTaqs = true;
        gnSegmentScoreMode = NH_SEGMODE_AVG;
        snSegmentScoreMode = NH_SEGMODE_AVG;
        gnScoreThresh = 0.5;
        snScoreThresh = 0.5;
        gnWeight = 0.8;
```

```
        snWeight = 1.0;
        break;

    case  NH_PARMS_ARABIC:
        scoreThresh = 0.63;
        useGnLeftBias = false;
        useSnLeftBias = false;
        matchGnIntial = true;
        matchSnIntial = true;
        gnInitialScore = 0.85;
        snInitialScore = 0.85;
        gnInitialOnInitialMatchScore = 1.0;
        snInitialOnInitialMatchScore = 1.0;
        useGnVariants = false;
        useSnVariants = false;
        fnuScore = 0.60;
        nfnScore = 0.65;
        lnuScore = 0.6;
        nlnScore = 0.65;
        gnAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
        snAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
        gnAnchorFactor = 0.0;
        snAnchorFactor = 0.0;
        gnOOPSFactor = 0.7;
        snOOPSFactor = 0.9;
        disGnTAQFactor = 0.7;
        absDelGnTAQFactor = 0.9;
        absDisGnTAQFactor = 0.8;
        delGnTAQFactor = 0.85;
        disSnTAQFactor = 0.7;
        absDelSnTAQFactor = 0.9;
        absDisSnTAQFactor = 0.8;
        delSnTAQFactor = 0.85;
        checkGnCompressedName = true;
        checkSnCompressedName = true;
        gnCompressedNameScore = 0.9;
        snCompressedNameScore = 0.9;
        scoreGnTaqs = true;
        scoreSnTaqs = true;
        gnSegmentScoreMode = NH_SEGMODE_AVG;
        snSegmentScoreMode = NH_SEGMODE_AVG;
        gnScoreThresh = 0.63;
        snScoreThresh = 0.63;
        gnWeight = 1.0;
        snWeight = 0.8;
        break;

    case  NH_PARMS_CHINESE:
        scoreThresh = 0.70;
        useGnLeftBias = false;
        useSnLeftBias = false;
        matchGnIntial = false;
        matchSnIntial = false;
        gnInitialScore = 0.0;
        snInitialScore = 0.0;
        gnInitialOnInitialMatchScore = 0.0;
        snInitialOnInitialMatchScore = 0.0;
        useGnVariants = true;
        useSnVariants = true;
        fnuScore = 0.60;
        nfnScore = 0.65;
```

```
        lnuScore = 0.6;
        nlnScore = 0.65;
        gnAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
        snAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
        gnAnchorFactor = 0.0;
        snAnchorFactor = 0.0;
        gnOOPSFactor = 0.0;
        snOOPSFactor = 1.0;
        disGnTAQFactor = 0.7;
        absDelGnTAQFactor = 0.9;
        absDisGnTAQFactor = 0.8;
        delGnTAQFactor = 0.85;
        disSnTAQFactor = 0.7;
        absDelSnTAQFactor = 0.9;
        absDisSnTAQFactor = 0.8;
        delSnTAQFactor = 0.85;
        checkGnCompressedName = false;
        checkSnCompressedName = false;
        gnCompressedNameScore = 0.0;
        snCompressedNameScore = 0.0;
        scoreGnTaqs = true;
        scoreSnTaqs = true;
        gnSegmentScoreMode = NH_SEGMODE_LOWEST;
        snSegmentScoreMode = NH_SEGMODE_AVG;
        gnScoreThresh = 0.7;
        snScoreThresh = 0.7;
        gnWeight = 0.8;
        snWeight = 1.0;
        break;

case    NH_PARMS_HISPANIC:
        scoreThresh = 0.60;
        useGnLeftBias = false;
        useSnLeftBias = false;
        matchGnIntial = true;
        matchSnIntial = true;
        gnInitialScore = 0.85;
        snInitialScore = 0.85;
        gnInitialOnInitialMatchScore = 1.0;
        snInitialOnInitialMatchScore = 1.0;
        useGnVariants = true;
        useSnVariants = true;
        fnuScore = 0.60;
        nfnScore = 0.65;
        lnuScore = 0.6;
        nlnScore = 0.65;
        gnAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
        snAnchorSegmentMode = NH_ANCHOR_SEG_FIRST;
        gnAnchorFactor = 0.0;
        snAnchorFactor = 0.70;
        gnOOPSFactor = 0.6;
        snOOPSFactor = 0.6;
        disGnTAQFactor = 0.7;
        absDelGnTAQFactor = 0.9;
        absDisGnTAQFactor = 0.8;
        delGnTAQFactor = 0.85;
        disSnTAQFactor = 0.7;
        absDelSnTAQFactor = 0.9;
        absDisSnTAQFactor = 0.8;
        delSnTAQFactor = 0.85;
        checkGnCompressedName = true;
```

```
                checkSnCompressedName = true;
                gnCompressedNameScore = 0.9;
                snCompressedNameScore = 0.9;
                scoreGnTaqs = true;
                scoreSnTaqs = true;
                gnSegmentScoreMode = NH_SEGMODE_AVG;
                snSegmentScoreMode = NH_SEGMODE_AVG;
                gnScoreThresh = 0.6;
                snScoreThresh = 0.6;
                gnWeight = 0.8;
                snWeight = 1.0;
                break;

            case  NH_PARMS_KOREAN:                          // Parameters
tuned for Korean names.
                scoreThresh = 0.66;
                useGnLeftBias = false;
                useSnLeftBias = false;
                matchGnIntial = false;
                matchSnIntial = false;
                gnInitialScore = 0.0;
                snInitialScore = 0.0;
                gnInitialOnInitialMatchScore = 0.0;
                snInitialOnInitialMatchScore = 0.0;
                useGnVariants = true;
                useSnVariants = true;
                fnuScore = 0.60;
                nfnScore = 0.65;
                lnuScore = 0.6;
                nlnScore = 0.65;
                gnAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
                snAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
                gnAnchorFactor = 0.0;
                snAnchorFactor = 0.0;
                gnOOPSFactor = 0.69;
                snOOPSFactor = 0.63;
                disGnTAQFactor = 0.7;
                absDelGnTAQFactor = 0.9;
                absDisGnTAQFactor = 0.8;
                delGnTAQFactor = 0.85;
                disSnTAQFactor = 0.7;
                absDelSnTAQFactor = 0.9;
                absDisSnTAQFactor = 0.8;
                delSnTAQFactor = 0.85;
                checkGnCompressedName = false;
                checkSnCompressedName = false;
                gnCompressedNameScore = 0.0;
                snCompressedNameScore = 0.0;
                scoreGnTaqs = true;
                scoreSnTaqs = true;
                gnSegmentScoreMode = NH_SEGMODE_AVG;
                snSegmentScoreMode = NH_SEGMODE_AVG;
                gnScoreThresh = 0.69;
                snScoreThresh = 0.63;
                gnWeight = 0.8;
                snWeight = 1.0;
                break;

            case  NH_PARMS_RUSSIAN:                         // Parameters
 tuned for Russian names.
                scoreThresh = 0.61;
```

```
                useGnLeftBias = false;
                useSnLeftBias = true;
                matchGnIntial = true;
                matchSnIntial = true;
                gnInitialScore = 0.85;
                snInitialScore = 0.85;
                gnInitialOnInitialMatchScore = 1.0;
                snInitialOnInitialMatchScore = 1.0;
                useGnVariants = false;
                useSnVariants = false;
                fnuScore = 0.60;
                nfnScore = 0.65;
                lnuScore = 0.6;
                nlnScore = 0.65;
                gnAnchorSegmentMode = NH_ANCHOR_SEG_FIRST;
                snAnchorSegmentMode = NH_ANCHOR_SEG_NONE;
                gnAnchorFactor = 0.60;
                snAnchorFactor = 0.00;
                gnOOPSFactor = 0.65;
                snOOPSFactor = 0.8;
                disGnTAQFactor = 0.7;
                absDelGnTAQFactor = 0.9;
                absDisGnTAQFactor = 0.8;
                delGnTAQFactor = 0.85;
                disSnTAQFactor = 0.7;
                absDelSnTAQFactor = 0.9;
                absDisSnTAQFactor = 0.8;
                delSnTAQFactor = 0.85;
                checkGnCompressedName = false;
                checkSnCompressedName = false;
                gnCompressedNameScore = 0.0;
                snCompressedNameScore = 0.0;
                gnSegmentScoreMode = NH_SEGMODE_HIGHEST;
                snSegmentScoreMode = NH_SEGMODE_AVG;
                gnScoreThresh = 0.6;
                snScoreThresh = 0.62;
                gnWeight = 0.8;
                snWeight = 1.0;
                break;
        }       //    end of switch
}


NHCompParms::NHCompParms(istream &inStream)
{
        int   compParmsVersion;

        if (inStream.good())    {
                inStream.read((char *)&compParmsVersion, sizeof(int));

                inStream.read((char *)&scoreThresh, sizeof(double));
                inStream.read((char *)&useGnLeftBias, sizeof(bool));
                inStream.read((char *)&useSnLeftBias, sizeof(bool));
                inStream.read((char *)&matchGnIntial, sizeof(bool));
                inStream.read((char *)&matchSnIntial, sizeof(bool));
                inStream.read((char *)&gnInitialScore, sizeof(double));
                inStream.read((char *)&snInitialScore, sizeof(double));
                inStream.read((char *)&useGnVariants, sizeof(bool));
                inStream.read((char *)&useSnVariants, sizeof(bool));
                inStream.read((char *)&fnuScore, sizeof(double));
                inStream.read((char *)&nfnScore, sizeof(double));
```

```
            inStream.read((char *)&lnuScore, sizeof(double));
            inStream.read((char *)&nlnScore, sizeof(double));

            inStream.read((char *)&gnSegmentScoreMode,
sizeof(NHSegScoreMode));
            inStream.read((char *)&snSegmentScoreMode,
sizeof(NHSegScoreMode));
            inStream.read((char *)&gnAnchorSegmentMode,
sizeof(NHAnchorSegMode));
            inStream.read((char *)&snAnchorSegmentMode,
sizeof(NHAnchorSegMode));

            inStream.read((char *)&gnAnchorFactor, sizeof(double));
            inStream.read((char *)&snAnchorFactor, sizeof(double));
            inStream.read((char *)&gnOOPSFactor, sizeof(double));
            inStream.read((char *)&snOOPSFactor, sizeof(double));

            inStream.read((char *)&scoreGnTaqs, sizeof(bool));
            inStream.read((char *)&scoreSnTaqs, sizeof(bool));

            inStream.read((char *)&absDelGnTAQFactor, sizeof(double));
            inStream.read((char *)&absDisGnTAQFactor, sizeof(double));
            inStream.read((char *)&absDelSnTAQFactor, sizeof(double));
            inStream.read((char *)&absDisSnTAQFactor, sizeof(double));
            inStream.read((char *)&delGnTAQFactor, sizeof(double));
            inStream.read((char *)&delSnTAQFactor, sizeof(double));
            inStream.read((char *)&disGnTAQFactor, sizeof(double));
            inStream.read((char *)&disSnTAQFactor, sizeof(double));

            inStream.read((char *)&checkGnCompressedName, sizeof(bool));
            inStream.read((char *)&checkSnCompressedName, sizeof(bool));

            inStream.read((char *)&gnCompressedNameScore,
sizeof(double));
            inStream.read((char *)&snCompressedNameScore,
sizeof(double));

            inStream.read((char *)&gnScoreThresh, sizeof(double));
            inStream.read((char *)&snScoreThresh, sizeof(double));

            inStream.read((char *)&gnWeight, sizeof(double));
            inStream.read((char *)&snWeight, sizeof(double));

            inStream.read((char *)&gnInitialOnInitialMatchScore,
sizeof(double));
            inStream.read((char *)&snInitialOnInitialMatchScore,
sizeof(double));

            status = NH_SUCCESS;
      }
      else
            status = NH_COMP_PARMS_BAD_STREAM_ON_CONSTRUCT;
}


NHCompParms::~NHCompParms()
{
}


NHReturnCode      NHCompParms::archiveData(ostream &outStream)
```

```
{
//    comp parms file version history
//          1.0         -     first version
      int                                   compParmsVersion = 1;
      NHReturnCode      rc = NH_SUCCESS;

      if (outStream.good())   {
            outStream.write((char *)&compParmsVersion, sizeof(int));

            outStream.write((char *)&scoreThresh, sizeof(double));
            outStream.write((char *)&useGnLeftBias, sizeof(bool));
            outStream.write((char *)&useSnLeftBias, sizeof(bool));
            outStream.write((char *)&matchGnIntial, sizeof(bool));
            outStream.write((char *)&matchSnIntial, sizeof(bool));
            outStream.write((char *)&gnInitialScore, sizeof(double));
            outStream.write((char *)&snInitialScore, sizeof(double));
            outStream.write((char *)&useGnVariants, sizeof(bool));
            outStream.write((char *)&useSnVariants, sizeof(bool));
            outStream.write((char *)&fnuScore, sizeof(double));
            outStream.write((char *)&nfnScore, sizeof(double));
            outStream.write((char *)&lnuScore, sizeof(double));
            outStream.write((char *)&nlnScore, sizeof(double));

            outStream.write((char *)&gnSegmentScoreMode,
sizeof(NHSegScoreMode));
            outStream.write((char *)&snSegmentScoreMode,
sizeof(NHSegScoreMode));
            outStream.write((char *)&gnAnchorSegmentMode,
sizeof(NHAnchorSegMode));
            outStream.write((char *)&snAnchorSegmentMode,
sizeof(NHAnchorSegMode));

            outStream.write((char *)&gnAnchorFactor, sizeof(double));
            outStream.write((char *)&snAnchorFactor, sizeof(double));
            outStream.write((char *)&gnOOPSFactor, sizeof(double));
            outStream.write((char *)&snOOPSFactor, sizeof(double));

            outStream.write((char *)&scoreGnTaqs, sizeof(bool));
            outStream.write((char *)&scoreSnTaqs, sizeof(bool));

            outStream.write((char *)&absDelGnTAQFactor, sizeof(double));
            outStream.write((char *)&absDisGnTAQFactor, sizeof(double));
            outStream.write((char *)&absDelSnTAQFactor, sizeof(double));
            outStream.write((char *)&absDisSnTAQFactor, sizeof(double));
            outStream.write((char *)&delGnTAQFactor, sizeof(double));
            outStream.write((char *)&delSnTAQFactor, sizeof(double));
            outStream.write((char *)&disGnTAQFactor, sizeof(double));
            outStream.write((char *)&disSnTAQFactor, sizeof(double));

            outStream.write((char *)&checkGnCompressedName,
sizeof(bool));
            outStream.write((char *)&checkSnCompressedName,
sizeof(bool));

            outStream.write((char *)&gnCompressedNameScore,
sizeof(double));
            outStream.write((char *)&snCompressedNameScore,
sizeof(double));

            outStream.write((char *)&gnScoreThresh, sizeof(double));
            outStream.write((char *)&snScoreThresh, sizeof(double));
```

```
            outStream.write((char *)&gnWeight, sizeof(double));
            outStream.write((char *)&snWeight, sizeof(double));

            outStream.write((char *)&gnInitialOnInitialMatchScore,
sizeof(double));
            outStream.write((char *)&snInitialOnInitialMatchScore,
sizeof(double));
      }
      else
            rc = NH_COMP_PARMS_BAD_STREAM_ON_ARCHIVE;

      return rc;
}


NHReturnCode      NHCompParms::setScoreThresh(double aThresh)
{
      NHReturnCode            errorCode;

      if ((aThresh < 0.0) || (aThresh > 1.0))
            errorCode = NH_INVALID_SCORE_THRESH;
      else  {
            scoreThresh = aThresh;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


void  NHCompParms::setUseGnLeftBias(bool aBool)
{
      useGnLeftBias = aBool;
}

void  NHCompParms::setUseSnLeftBias(bool aBool)
{
      useSnLeftBias = aBool;
}


void  NHCompParms::setMatchGnIntial(bool aBool)
{
      matchGnIntial = aBool;
}


void  NHCompParms::setMatchSnIntial(bool aBool)
{
      matchSnIntial = aBool;
}


NHReturnCode      NHCompParms::setGnInitialScore(double aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_GN_INIT_SCORE;
      else  {
```

```
            gnInitialScore = aScore;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


NHReturnCode      NHCompParms::setSnInitialScore(double aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_NH_INIT_SCORE;
      else  {
            snInitialScore = aScore;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


NHReturnCode      NHCompParms::setGnInitialOnInitialMatchScore(double
aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_GN_INIT_ON_INIT_MATCH_SCORE;
      else  {
            gnInitialOnInitialMatchScore = aScore;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


NHReturnCode      NHCompParms::setSnInitialOnInitialMatchScore(double
aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_NH_INIT_ON_INIT_MATCH_SCORE;
      else  {
            snInitialOnInitialMatchScore = aScore;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


void  NHCompParms::setUseGnVariants(bool aBool)
{
      useGnVariants = aBool;
}
```

```
void  NHCompParms::setUseSnVariants(bool aBool)
{
      useSnVariants = aBool;
}


NHReturnCode      NHCompParms::setNFNScore(double aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_NFN_SCORE;
      else  {
            nfnScore = aScore;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


NHReturnCode      NHCompParms::setFNUScore(double aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_FNU_SCORE;
      else  {
            fnuScore = aScore;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


NHReturnCode      NHCompParms::setNLNScore(double aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_NLN_SCORE;
      else  {
            nlnScore = aScore;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


NHReturnCode      NHCompParms::setLNUScore(double aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_LNU_SCORE;
      else  {
            lnuScore = aScore;
            errorCode = NH_SUCCESS;
      }
```

```
	return errorCode;
}

NHReturnCode	NHCompParms::setGnScoreThresh(double aThresh)
{
	NHReturnCode		errorCode;

	if ((aThresh < 0.0) || (aThresh > 1.0))
		errorCode = NH_INVALID_GN_THRESH;
	else {
		gnScoreThresh = aThresh;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}

NHReturnCode	NHCompParms::setSnScoreThresh(double aThresh)
{
	NHReturnCode		errorCode;

	if ((aThresh < 0.0) || (aThresh > 1.0))
		errorCode = NH_INVALID_NH_THRESH;
	else {
		snScoreThresh = aThresh;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}

NHReturnCode	NHCompParms::setGnWeight(double aWeight)
{
	NHReturnCode		errorCode;

	if ((aWeight < 0.0) || (aWeight > 1.0))
		errorCode = NH_INVALID_GN_WEIGHT;
	else {
		gnWeight = aWeight;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}

NHReturnCode	NHCompParms::setSnWeight(double aWeight)
{
	NHReturnCode		errorCode;

	if ((aWeight < 0.0) || (aWeight > 1.0))
		errorCode = NH_INVALID_NH_WEIGHT;
	else {
		snWeight = aWeight;
		errorCode = NH_SUCCESS;
	}
```

```
	return errorCode;
}

void	NHCompParms::setGnSegmentScoreMode(NHSegScoreMode aMode)
{
	gnSegmentScoreMode = aMode;
}

void	NHCompParms::setSnSegmentScoreMode(NHSegScoreMode aMode)
{
	snSegmentScoreMode = aMode;
}

void	NHCompParms::setGnAnchorSegmentMode(NHAnchorSegMode anAnchorMode)
{
	gnAnchorSegmentMode = anAnchorMode;
}

void	NHCompParms::setSnAnchorSegmentMode(NHAnchorSegMode anAnchorMode)
{
	snAnchorSegmentMode = anAnchorMode;
}

NHReturnCode	NHCompParms::setGnAnchorFactor(double aFactor)
{
	NHReturnCode		errorCode;

	if ((aFactor < 0.0) || (aFactor > 1.0))
		errorCode = NH_INVALID_GN_ANCHOR_FACTOR;
	else	{
		gnAnchorFactor = aFactor;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}

NHReturnCode	NHCompParms::setSnAnchorFactor(double aFactor)
{
	NHReturnCode		errorCode;

	if ((aFactor < 0.0) || (aFactor > 1.0))
		errorCode = NH_INVALID_NH_ANCHOR_FACTOR;
	else	{
		snAnchorFactor = aFactor;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}

NHReturnCode	NHCompParms::setGnOOPSFactor(double aFactor)
{
	NHReturnCode		errorCode;
```

```
        if ((aFactor < 0.0) || (aFactor > 1.0))
                errorCode = NH_INVALID_GN_OOPS_FACTOR;
        else  {
                gnOOPSFactor = aFactor;
                errorCode = NH_SUCCESS;
        }

        return errorCode;
}


NHReturnCode        NHCompParms::setSnOOPSFactor(double aFactor)
{
        NHReturnCode                errorCode;

        if ((aFactor < 0.0) || (aFactor > 1.0))
                errorCode = NH_INVALID_NH_OOPS_FACTOR;
        else  {
                snOOPSFactor = aFactor;
                errorCode = NH_SUCCESS;
        }

        return errorCode;
}


NHReturnCode        NHCompParms::setAbsDelGnTAQFactor(double aFactor)
{
        NHReturnCode                errorCode;

        if ((aFactor < 0.0) || (aFactor > 1.0))
                errorCode = NH_INVALID_ABS_DEL_GN_TAQ_FACTOR;
        else  {
                absDelGnTAQFactor = aFactor;
                errorCode = NH_SUCCESS;
        }

        return errorCode;
}


NHReturnCode        NHCompParms::setAbsDisGnTAQFactor(double aFactor)
{
        NHReturnCode                errorCode;

        if ((aFactor < 0.0) || (aFactor > 1.0))
                errorCode = NH_INVALID_ABS_DIS_GN_TAQ_FACTOR;
        else  {
                absDisGnTAQFactor = aFactor;
                errorCode = NH_SUCCESS;
        }

        return errorCode;
}


NHReturnCode        NHCompParms::setAbsDelSnTAQFactor(double aFactor)
{
        NHReturnCode                errorCode;
```

```
	if ((aFactor < 0.0) || (aFactor > 1.0))
		errorCode = NH_INVALID_ABS_DEL_NH_TAQ_FACTOR;
	else	{
		absDelSnTAQFactor = aFactor;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}


NHReturnCode	NHCompParms::setAbsDisSnTAQFactor(double aFactor)
{
	NHReturnCode		errorCode;

	if ((aFactor < 0.0) || (aFactor > 1.0))
		errorCode = NH_INVALID_ABS_DIS_NH_TAQ_FACTOR;
	else	{
		absDisSnTAQFactor = aFactor;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}


NHReturnCode	NHCompParms::setDelGnTAQFactor(double aFactor)
{
	NHReturnCode		errorCode;

	if ((aFactor < 0.0) || (aFactor > 1.0))
		errorCode = NH_INVALID_DEL_GN_TAQ_FACTOR;
	else	{
		delGnTAQFactor = aFactor;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}


NHReturnCode	NHCompParms::setDelSnTAQFactor(double aFactor)
{
	NHReturnCode		errorCode;

	if ((aFactor < 0.0) || (aFactor > 1.0))
		errorCode = NH_INVALID_DEL_NH_TAQ_FACTOR;
	else	{
		delSnTAQFactor = aFactor;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}


NHReturnCode	NHCompParms::setDisGnTAQFactor(double aFactor)
{
	NHReturnCode		errorCode;

	if ((aFactor < 0.0) || (aFactor > 1.0))
```

```
            errorCode = NH_INVALID_DIS_GN_TAQ_FACTOR;
      else  {
            disGnTAQFactor = aFactor;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


NHReturnCode      NHCompParms::setDisSnTAQFactor(double aFactor)
{
      NHReturnCode            errorCode;

      if ((aFactor < 0.0) || (aFactor > 1.0))
            errorCode = NH_INVALID_DIS_NH_TAQ_FACTOR;
      else  {
            disSnTAQFactor = aFactor;
            errorCode = NH_SUCCESS;
      }

      return errorCode;
}


void  NHCompParms::setScoreGnTAQs(bool aBool)
{
      scoreGnTaqs = aBool;
}


void  NHCompParms::setScoreSnTAQs(bool aBool)
{
      scoreSnTaqs = aBool;
}


void        NHCompParms::setCheckGnCompressedName(bool aBool)
{
      checkGnCompressedName = aBool;
}


void        NHCompParms::setCheckSnCompressedName(bool aBool)
{
      checkSnCompressedName = aBool;
}


NHReturnCode            NHCompParms::setGnCompressedNameScore(double
aScore)
{
      NHReturnCode            errorCode;

      if ((aScore < 0.0) || (aScore > 1.0))
            errorCode = NH_INVALID_GN_COMPRESSED_NAME_SCORE;
      else  {
            gnCompressedNameScore = aScore;
            errorCode = NH_SUCCESS;
      }
```

```
	return errorCode;
}


NHReturnCode		NHCompParms::setSnCompressedNameScore(double
aScore)
{
	NHReturnCode		errorCode;

	if ((aScore < 0.0) || (aScore > 1.0))
		errorCode = NH_INVALID_NH_COMPRESSED_NAME_SCORE;
	else {
		snCompressedNameScore = aScore;
		errorCode = NH_SUCCESS;
	}

	return errorCode;
}


bool		NHCompParms::operator==(NHCompParms &other)
{
	bool	rc;

	rc = ((scoreThresh == other.scoreThresh) &&
			(useGnLeftBias == other.useGnLeftBias) &&
			(useSnLeftBias == other.useSnLeftBias) &&
			(matchGnIntial == other.matchGnIntial) &&
			(matchSnIntial == other.matchSnIntial) &&
			(gnInitialScore == other.gnInitialScore) &&
			(snInitialScore == other.snInitialScore) &&
			(useGnVariants == other.useGnVariants) &&
			(useSnVariants == other.useSnVariants) &&
			(fnuScore == other.fnuScore) &&
			(nfnScore == other.nfnScore) &&
			(lnuScore == other.lnuScore) &&
			(nlnScore == other.nlnScore) &&
			(gnSegmentScoreMode == other.gnSegmentScoreMode)
&&
			(snSegmentScoreMode == other.snSegmentScoreMode)
&&
			(gnAnchorSegmentMode ==
other.gnAnchorSegmentMode) &&
			(snAnchorSegmentMode ==
other.snAnchorSegmentMode) &&
			(gnAnchorFactor == other.gnAnchorFactor) &&
			(snAnchorFactor == other.snAnchorFactor) &&
			(gnOOPSFactor == other.gnOOPSFactor) &&
			(snOOPSFactor == other.snOOPSFactor) &&
			(gnWeight == other.gnWeight) &&
			(snWeight == other.snWeight) &&
			(gnScoreThresh == other.gnScoreThresh) &&
			(snScoreThresh == other.snScoreThresh) &&
			(scoreGnTaqs == other.scoreGnTaqs) &&
			(scoreSnTaqs == other.scoreSnTaqs) &&
			(absDelGnTAQFactor == other.absDelGnTAQFactor)
&&
			(absDisGnTAQFactor == other.absDisGnTAQFactor)
&&
			(absDelSnTAQFactor == other.absDelSnTAQFactor)
&&
```

```
                        (absDisSnTAQFactor == other.absDisSnTAQFactor)
&&
                        (delGnTAQFactor == other.delGnTAQFactor) &&
                        (delSnTAQFactor == other.delSnTAQFactor) &&
                        (disGnTAQFactor == other.disGnTAQFactor) &&
                        (disSnTAQFactor == other.disSnTAQFactor) &&
                        (checkGnCompressedName ==
other.checkGnCompressedName) &&
                        (checkSnCompressedName ==
other.checkSnCompressedName) &&
                        (gnCompressedNameScore ==
other.gnCompressedNameScore) &&
                        (snCompressedNameScore ==
other.snCompressedNameScore) &&
                        (gnInitialOnInitialMatchScore ==
other.gnInitialOnInitialMatchScore) &&
                        (snInitialOnInitialMatchScore ==
other.snInitialOnInitialMatchScore));
      return rc;
}


NHReturnCode                    NHCompParms::getStatus()
{
      return status;
}
```

```
//    File:  NH_variant_taq_globals.h
//
//    Description:
//
//          Functions to manage the global variant and TAQ resources.
//          We manage the TAQ and variant tables as global resources
//          so that each SNCompParms object does not need to create its
//          own copy of them.  We provide these global functions so that
//          we can control the variables in one location.
//
//
//    History:
//
//          9/08/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#ifndef     NH_VARIANT_TAQ_GLOBALS_DEFFED
#define     NH_VARIANT_TAQ_GLOBALS_DEFFED


#include    "NH_culture_codes.h"

//    function to return pointers to the global SN and GN Variant Tables
NHVariantTable    *NH_getVariantTable(NH_VARIANT_TABLE_TYPES
variantTableType);

NHTAQTable  *NH_getTAQTable();



#endif
```

```
//    File:  NH_variant_taq_globals.cpp
//
//    Description:
//
//          Functions to manage the global variant and TAQ resources.
//          We manage the TAQ and variant tables as global resources
//          so that each NHCompParms object does not need to create its
//          own copy of them.  We provide these global functions so that
//          we can control the variables in one location.
//
//          We should provide some sort of thread protection around
these
//          resources to make sure that two competing threads do not
attempt
//          to grab these resources during creation time.  How can we do
this
//          portably?.
//
//
//    History:
//
//          9/08/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#include    <string.h>


#include    "NH_util.hpp"
#include    "NHVariantTable.hpp"
#include    "NHTAQTable.hpp"

#include    "NH_variant_taq_globals.h"

//    define SN and GN variant tables
NHVariantTable    *NH_snVariantTable = NULL;
NHVariantTable    *NH_gnVariantTable = NULL;

//    define a single TAQ table
NHTAQTable  *NH_taqTable = NULL;



//    functions to create and return pointers to the tables

NHVariantTable    *NH_getVariantTable(NH_VARIANT_TABLE_TYPES
variantTableType)
{
      NHVariantTable    *tablePtr;
      NHVariantTable    **tablePtrPtr = NULL;

      switch      (variantTableType)      {
            case  NH_SURNAME_VARIANTS:
                  tablePtr = NH_snVariantTable;
                  tablePtrPtr = &NH_snVariantTable;
                  break;
            case  NH_GIVENNAME_VARIANTS:
                  tablePtr = NH_gnVariantTable;
                  tablePtrPtr = &NH_gnVariantTable;
                  break;
```

```
            default:
                  tablePtr = NULL;
      }
      if (tablePtr == NULL)   {
            tablePtr = new
NHVariantTable(variantTableType);         //    create the table
            if (tablePtrPtr != NULL)
                  *tablePtrPtr = tablePtr;      //    assign the global
variable
      }
      return      tablePtr;
}


NHTAQTable  *NH_getTAQTable()
{
      if (NH_taqTable == NULL)      {
            NH_taqTable = new
NHTAQTable(NH_PRODUCTION_TAQ_TABLE);            //    create the table
      }
      return      NH_taqTable;
}
```

```
//    File:  NH_util.cpp
//
//    Description:
//
//          Implementation of various utility functions used in the
SNAPI
//
//
//    History:
//
//          5/15/97     EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//


#include    <string.h>


#include    "NH_util.hpp"
#include    "NHCompParms.hpp"



//    function to remove leading and trailing spaces from a string
//    in place.
//  Strips the string at either end or both ends.
//  Stripchars specify the characters that should
//  be stripped.  We start by seeing if they want the
//  trailing chars stripped, which is easy.  We simply
//  work backwards from the end of the string, looking for
//  the first non-strippable character, and terminate the
//  string just past that character.  Then if they wanted
//  leading chars stripped, we work forwards to the first
//  non-strippable char, and then move that and each following
//  char to the beginning of the string.
void  NH_strip(char *aString)
{
  char *end_point;
  char *ch;
  int  len;

  if ((len = strlen(aString)) != 0) { //  if there is a string
            //  start at end
            end_point = aString + len - 1;

            //  and work back till we get a non-space or get to
            //  the begining of our string, chopping off what's left.
            //  Also make sure we don't zoom right past the beginning of
the
            //  string.
            for (; strchr(NH_DEFAULT_WHITESPACE, *end_point) != NULL &&
end_point != aString; end_point--)
                  ;
            //  if string was all whitespace
            if ((end_point == aString) && strchr(NH_DEFAULT_WHITESPACE,
*aString) != NULL)
                  *aString = EOS;    //  erase it all, and we're done,
could return here
            else
                  *(end_point + 1) = EOS;     //  just chop off excess
```

```
blanks

            //  make sure there is still a string, since it might
            //  have been stripped entirely above.
            if (*aString) {
                  //  now find first non space.  we know string has at
least one
                  //  nonwhite space, so we don't have to check for
NULL.
                  for (ch = aString; strchr(NH_DEFAULT_WHITESPACE, *ch)
!= NULL; ch++)
                        ;
                  if (ch != aString) {// if there were leading spaces,
move the block back
                        char  *target = aString;
                        while (*ch != EOS) {
                              *target = *ch;
                              target++;
                              ch++;
                        }
                        //  and get the null char also
                        *target = *ch;
                  } //  end if (are there leading spaces?)
            } //  end if (and text left?)
  } //  end (is there a string at all ?)
}


char  *     NH_strrchr(char *stringStart, char *searchPos, char
searchChar)
{
      while (1)   {
            if (*searchPos == searchChar)
                  break;
            if (searchPos == stringStart) {
                  searchPos = NULL;       //    string not found, so
return NULL
                  break;
            }
            searchPos--;
      }
      return searchPos;
}
```

```
//
//    File:  NH_queens_arrays.hpp
//
//    Description:
//
//          Contains global definitions and declarations for the valid
//          combinations of indexes for the best score calculation
//
//
//    History:
//
//          6/4/97      EFB         Created
//          3/20/98     EFB         Changed names to NH from SN
//

typedef     unsigned char byte;


      byte  twoByTwo[] = {1, 0,
                                                                  0, 1};

      byte  twoByThree[] = {  1, 2,

1, 0,

2, 1,

2, 0,

0, 1,

0, 2};

      byte  twoByFour[] = {   1, 2,

1, 3,

1, 0,

2, 1,

2, 3,

2, 0,

3, 1,

3, 2,

3, 0,

0, 1,

0, 2,

0, 3};

      byte  twoByFive[] = {   1, 2,

1, 3,
```

```
1, 4,
1, 0,
2, 1,
2, 3,
2, 4,
2, 0,
3, 1,
3, 2,
3, 4,
3, 0,
4, 1,
4, 2,
4, 3,
4, 0,
0, 1,
0, 2,
0, 3,
0, 4};
      byte  threeByThree[] = {      1, 2, 0,
      1, 0, 2,
      2, 1, 0,
      2, 0, 1,
      0, 1, 2,
      0, 2, 1};
      byte  threeByFour[] = { 1, 2, 3,
      1, 2, 0,
      1, 3, 2,
      1, 3, 0,
      1, 0, 2,
      1, 0, 3,
```

```
2, 1, 3,
2, 1, 0,
2, 3, 1,
2, 3, 0,
2, 0, 1,
2, 0, 3,
3, 1, 2,
3, 1, 0,
3, 2, 1,
3, 2, 0,
3, 0, 1,
3, 0, 2,
0, 1, 2,
0, 1, 3,
0, 2, 1,
0, 2, 3,
0, 3, 1,
0, 3, 2};
byte  threeByFive[] = { 1, 2, 3,
1, 2, 4,
1, 2, 0,
1, 3, 2,
1, 3, 4,
1, 3, 0,
1, 4, 2,
1, 4, 3,
1, 4, 0,
1, 0, 2,
1, 0, 3,
1, 0, 4,
2, 1, 3,
```

2, 1, 4,

2, 1, 0,

2, 3, 1,

2, 3, 4,

2, 3, 0,

2, 4, 1,

2, 4, 3,

2, 4, 0,

2, 0, 1,

2, 0, 3,

2, 0, 4,

3, 1, 2,

3, 1, 4,

3, 1, 0,

3, 2, 1,

3, 2, 4,

3, 2, 0,

3, 4, 1,

3, 4, 2,

3, 4, 0,

3, 0, 1,

3, 0, 2,

3, 0, 4,

4, 1, 2,

4, 1, 3,

4, 1, 0,

4, 2, 1,

4, 2, 3,

4, 2, 0,

4, 3, 1,

```
4, 3, 2,
4, 3, 0,
4, 0, 1,
4, 0, 2,
4, 0, 3,
0, 1, 2,
0, 1, 3,
0, 1, 4,
0, 2, 1,
0, 2, 3,
0, 2, 4,
0, 3, 1,
0, 3, 2,
0, 3, 4,
0, 4, 1,
0, 4, 2,
0, 4, 3};
byte  fourByFour[] =    {     1, 2, 3, 0,
1, 2, 0, 3,
1, 3, 0, 2,
1, 3, 2, 0,
1, 0, 2, 3,
1, 0, 3, 2,
2, 1, 3, 0,
2, 1, 0, 3,
2, 3, 1, 0,
2, 3, 0, 1,
2, 0, 1, 3,
2, 0, 3, 1,
3, 1, 2, 0,
3, 1, 0, 2,
```

```
3, 2, 1, 0,
3, 2, 0, 1,
3, 0, 1, 2,
3, 0, 2, 1,
0, 1, 2, 3,
0, 1, 3, 2,
0, 2, 1, 3,
0, 2, 3, 1,
0, 3, 1, 2,
0, 3, 2, 1};
byte  fourByFive[] =    {     1, 2, 3, 4,
1, 2, 3, 0,
1, 2, 4, 3,
1, 2, 4, 0,
1, 2, 0, 3,
1, 2, 0, 4,
1, 3, 2, 4,
1, 3, 2, 0,
1, 3, 4, 2,
1, 3, 4, 0,
1, 3, 0, 2,
1, 3, 0, 4,
1, 4, 2, 3,
1, 4, 2, 0,
1, 4, 3, 2,
1, 4, 3, 0,
1, 4, 0, 2,
1, 4, 0, 3,
1, 0, 2, 3,
1, 0, 2, 4,
```

1, 0, 3, 2,

1, 0, 3, 4,

1, 0, 4, 2,

1, 0, 4, 3,

2, 1, 3, 4,

2, 1, 3, 0,

2, 1, 4, 3,

2, 1, 4, 0,

2, 1, 0, 3,

2, 1, 0, 4,

2, 3, 1, 4,

2, 3, 1, 0,

2, 3, 4, 1,

2, 3, 4, 0,

2, 3, 0, 1,

2, 3, 0, 4,

2, 4, 1, 3,

2, 4, 1, 0,

2, 4, 3, 1,

2, 4, 3, 0,

2, 4, 0, 1,

2, 4, 0, 3,

2, 0, 1, 3,

2, 0, 1, 4,

2, 0, 3, 1,

2, 0, 3, 4,

2, 0, 4, 1,

2, 0, 4, 3,

3, 2, 1, 4,

3, 2, 1, 0,

3, 2, 4, 1,

3, 2, 4, 0,

3, 2, 0, 1,

3, 2, 0, 4,

3, 1, 2, 4,

3, 1, 2, 0,

3, 1, 4, 2,

3, 1, 4, 0,

3, 1, 0, 2,

3, 1, 0, 4,

3, 4, 2, 1,

3, 4, 2, 0,

3, 4, 1, 2,

3, 4, 1, 0,

3, 4, 0, 2,

3, 4, 0, 1,

3, 0, 2, 1,

3, 0, 2, 4,

3, 0, 1, 2,

3, 0, 1, 4,

3, 0, 4, 2,

3, 0, 4, 1,

4, 2, 3, 1,

4, 2, 3, 0,

4, 2, 1, 3,

4, 2, 1, 0,

4, 2, 0, 3,

4, 2, 0, 1,

4, 3, 2, 1,

4, 3, 2, 0,

4, 3, 1, 2,

```
/* Generated by VariantManager */
addVariant("ANN","ANITA",0.85,"E ");
addVariant("ANN","ANA",0.85,"E ");
addVariant("ANN","ANNIE",0.90,"E ");
addVariant("ANN","ANNA",0.85,"E ");
addVariant("ANN","ANNE",0.95,"E ");
addVariant("ANN","ANNETTE",0.85,"E ");
```

```
/* Generated by VariantManager */
addVariant("SON","SWUN",0.95,"C ");
addVariant("SON","SHON",0.95,"K ");
addVariant("SON","SOHN",0.95,"K ");
```

```
/* Generated by TAQManager */
addTAQValue("SENORITA",'T','N','X','X',"G ");
```